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John Clarence Cutter

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NEW SERIES OF 1887.

BEGINNER'S ANATOMY, PHYSIOLOGY, AND HYGIENE,

Including Scientific Instruction on the Effects of Stimulants and
Narcotics on the Growing Body.

By JOHN C. CUTTER, B.Sc., M.D.,

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required will be a pocket-knife, a saw, a thin-bladed bread-knife, several
hooks in handles (a barbless fish-hook tied to a pen-holder), and scissors.
Each anatomical statement is accompanied by a reference to an illustration.



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ANATOMY, PHYSIOLOGY, AND HYGIENE,
INCLUDING
SCIENTIFIC INSTRUCTION ON THE EFFECTS
OF
STIMULANTS AND NARCOTICS
ON THE
GROWING BODY.

BY
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"COMPREHENSIVE ANATOMY, PHYSIOLOGY, AND HYGIENE," ETC., ETC.

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PREFACE.

YOUNG pupils, in order to understand an object must receive definite ideas about the same. These definite ideas are best communicated by allowing the pupil to see or handle the object, or an object similar in nature. In order that they may understand the working of an apparatus, or part, they must be informed how to observe the phenomena of the part, and how to draw conclusions or comparisons from simple experiments.

That the *facts of anatomy* may be easier and better impressed on the mind, directions for the dissection of a rat or dog, and for the dissection of special parts of other animals are given. For these dissections the only tools required will be a pocket-knife, a saw, a thin-bladed bread-knife, several hooks in handles (a barbless fish-hook tied to a pen-holder), and scissors.

In order that the *phenomena of the living body* (physiology) may be better understood, directions are given where to observe and what to look for on the human body, or other animal bodies; also directions for illustrative simple experiments. The apparatus required is meagre: a student's microscope, bulb-syringe, fruit-jars, candle, etc.

The *health-hints* are largely deduced from the facts of structure and of the workings of the living body. The health-hints are mainly presented in the form of maxims, and the reason for the same is presented in the sentences following. Especial attention is directed to the prevention of diseases

arising through the use of impure air, water, and food. Simple directions for the management of a few common *emergent cases* are given.

The main facts concerning the injurious actions of *narcotics and stimulants* on (1) the structure, (2) the functions, and (3) the health of the parts, and of the whole of the growing person, are stated in direct, simple language. More *facts* could be adduced, but only those which a young pupil can readily appreciate have been presented.

The language of the book is simple and direct. Technical and long words have been, as far as possible, avoided. The pronunciation of the technical words (in the text), and the syllabication of the long words, will aid the young pupil. The paragraphs are brief, and each one is confined to a single topic. Though searching questions are appended, yet the head-lines of the sections and of the paragraphs well adapt the book for the topical method of recitation.

JOHN CLARENCE CUTTER.

WARREN, MASS., JUNE, 1887.

TO THE TEACHER.

It is suggested that the teacher carefully read the notes; that as far as possible the dissections, demonstrations, and experiments there outlined be carried out in the presence of the class; and that the management of emergent cases be fully and repeatedly practised before the pupils. The use of painted-plaster or *papier-maché* models and of CUTTER'S OUTLINE ANATOMICO-ZOOLOGICAL CHARTS is also to be commended.

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THE BEGINNER'S ANATOMY, PHYSIOLOGY, AND HYGIENE.

CHAPTER I.

GENERAL DEFINITIONS AND DEMONSTRATIONS.

1. Anatomy (a-nat'o-mi) is a description of the organs, or parts, of a body (*a*).

Examples.—The nails, the teeth, the heart, etc., are parts of the body.

2. Physiology (fiz-e-ol'o-je) treats of the healthy operations which take place in the living body.

Examples.—The blood-tubes convey the blood. The kid-neys cast out water and wastes. These are their *functions*, or duties.

3. Hygiene (hī'je-ēn) treats of the conditions favorable to health.

Examples.—Sun-light in the living-rooms, cleanliness, simple food, the avoidance of alcohol and tobacco, etc., favor health.

(n) **FOR THE TEACHER. Directions for General Demonstrations.**—Select a well-formed boy. Request him to remove most of his outer garments, and then to stand before the class. Point out, designate the limits, and name the following:

1. *Parts of the Body*: (a) head, neck, trunk; (b) arms (right and left) and limbs.

2. *Parts of the Head*: scalp, face, ears.

3. *Parts of the Face*: (a) fore-head, temples, cheeks, cheek-bones, chin, mouth; (b) nose, bridge of nose, nostrils; (c) eyes, eye-brows, eye-lids, eye-lashes; (d) mouth, lips, mucous membrane, teeth, tongue.

4. *Parts of the Neck*: nape, larynx (Adam's apple), the pulsating carotid artery, the outer, blue veins.

5. *Parts of the Trunk*: (a) thorax, abdomen, pelvis; (b) shoulders, spine, collar-bone, ribs, hips.

6. *Arms*: (a) arm, fore-arm, wrist, hand, palm of hand, fingers; (b) joints: shoulder, elbow, wrist, finger; (c) the varieties of motion at each joint.

7. *Hand*: (a) palm, back, fingers, nails; (b) fingers: index, middle, ring, little; (c) thumb.

8. *Limbs*: (a) thigh, patella, leg (shin and calf), ankle, foot; (b) sole, instep, heel, ball, toes, arches (make an impress in soft clay or plaster of Paris of the bottom of the foot, in order to show the two arches); (c) the varieties of motion at each joint.

9. *Symmetry*: Drop a plumb-line in front of the centre of the fore-head. Call attention to the right and left halves of the body; to the right and left parts, in succession from above, downwards; to the right and left aperture of the head (mouth excepted).

10. Require the members of the class to demonstrate the parts on the boy, naming the parts as they are indicated.

QUESTIONS.

1. What is anatomy? Mention parts of the body. 2. Of what does physiology treat? What are functions? 3. Define hygiene. What favors health?

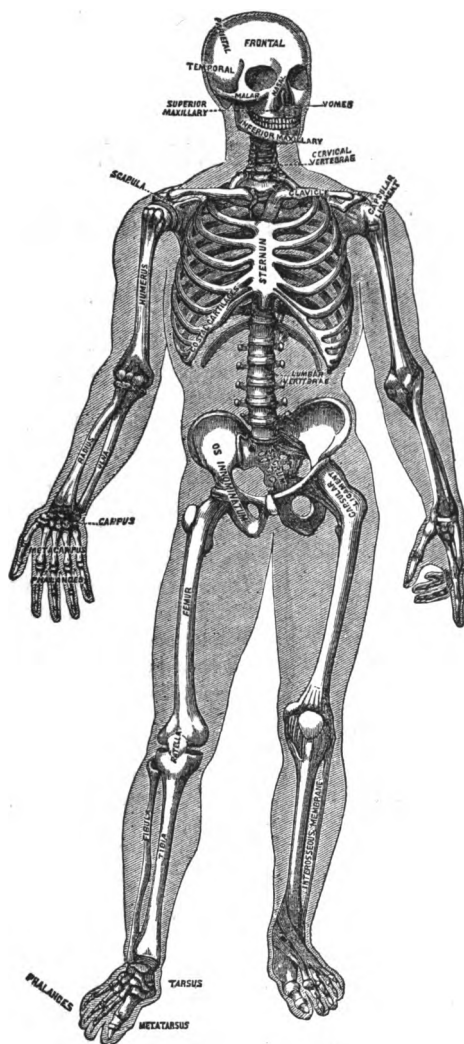


FIG. 2.

CHAPTER II.

THE BODY AND ITS COVERINGS.

TABLE OF THE BONES.

Head (22) .	{ Skull (8) .	Frontal (forehead).
		2 Temporal (temples).
		2 Parietal (side).
		Occipital (posterior base).
		Sphenoid (base).
		Ethmoid (base of nose).
	{ Face (14) .	2 Superior Maxillæ (upper jaw).
		2 Nasal (bridge of nose).
		2 Malar (cheek).
		2 Lachrymal (corner of orbit).
		2 Turbinated (within nostrils).
		2 Palate (posterior hard palate).
		Vomer (nasal partition).
		Inferior Maxilla (lower jaw).
Cervical Region (8) . . .	{	7 Cervical Vertebæ (neck).
		Hyoid Bone (base of tongue).
Thorax (37)	{	14 True, 6 False, 4 Floating Ribs.
		12 Dorsal Vertebæ (back).
		Sternum.
Upper Extremities (64) . .	{ Shoulder .	{ Clavicle (collar).
		{ Scapula (Shoulder-blade).
	{ Arm . .	{ Humerus (arm).
		{ Radius, Ulna (fore-arm).
	{ Hand . .	{ 8 Carpal (wrist).
		{ 5 Metacarpal (hand).
Lumbar Region (5) . . .	{	14 Phalanges (fingers).
		5 Lumbar Vertebæ (loins).

Pelvis (4)	{	2 Innominata.	
		Sacrum.	
		Coccyx.	
Lower Extremities (60) . .	{	Thigh . .	Femur.
		Leg . . .	{ Patella (knee-pan).
	{	Foot . .	Tibia (large bone).
			Fibula (outer bone).
	{	Foot . .	7 Tarsal (instep, heel).
			5 Metatarsal (arch).
			14 Phalanges (toes).

THE BONES.

4. The Frame-Work of the human body consists of two hundred *bones* (Fig. 2) held together by *liga-ments*.

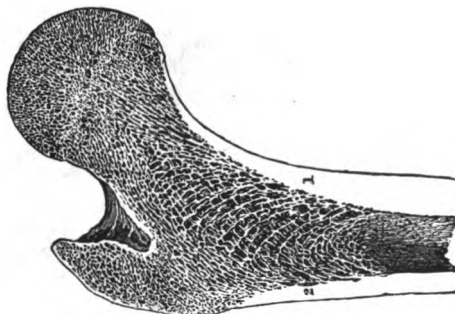


FIG. 8. Section of the femur (upper part).—1, 2, Hard outer shell. Inner cancellated structure.

5. The Bones are hard, like stone; are strong, like oak; and are pinkish-white in color. They are made of animal (jelly) and mineral (earthy) matters (*a*).

6. The Ligaments are stout like cords and are

flexible like leather straps. They are made up of white fibres. (Fig. 4.)

7. Uses of Bones.—They limit the height and breadth of the body. They form spaces, as for the eyes (Fig. 2), and cavities (skull-case) to shelter soft parts.

8. Deformities.—The bones of children and youth are flexible. If easy but firm pressure is put upon them they will become deformed bones. Hence the corset and “snug-fitting” shoes ought not to be worn by the young. The young baby should not try to walk too early, for “bandy-legs” may result.

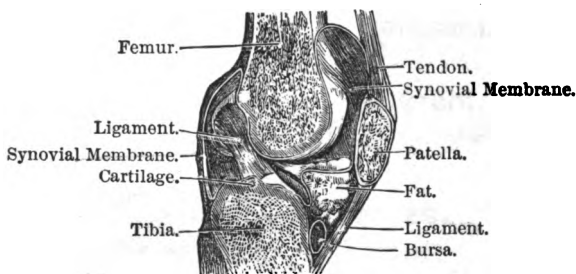


FIG. 4. *Section of knee-joint.*

THE JOINTS.

9. Joints.—The main joints are the shoulder, elbow, wrist, and finger; and hip, knee, and ankle. A joint is a union of two or more bones held in place by ligaments (*b*).

10. Cartilages.—The tips of the bones forming

a movable joint are covered with a layer of *car'ti-lage* (gristle). This layer is white, elastic, and smooth. (Fig. 4.)

11. Synovia.—The membrane lining the inner surface of the ligaments of a movable joint makes a fluid called *sy-no'vi-a* (joint-water). This fluid is slightly sticky, and looks like the white of an egg. (Fig. 4.)

12. Uses of the Parts of a Joint.—The *lig'a-ments* permit the ends of the bones to move on each other. The *car'ti-lage* makes a smooth and springy surface. The *fat*, inside of certain joints, fills up vacant places. The *sy-no'vi-a* acts on the surfaces as oil does on machines.

13. Summary.—
A *joint* is made up of { *Bones*,
 End-car'ti-la-ges,
 Lig'a-ments,
 Syn-o'vi-al mem-brane.

14. Coverings of the Frame-Work.—The frame-work is covered in by layer upon layer of *muscles* (lean meat), a layer of *fat*, and the *skin*. (Fig. 5.)

HYGIENE OF THE BONES.

15. Endeavor to keep an erect posture. If growing persons sit erect, stand erect, and keep erect when walking, then will their bones harden in correct forms. (190.)

16. *The carrying of a weight balanced on the head causes a person to stand erect.* The carriers of slate are erect, fine-appearing men and women.

INJURIOUS EFFECTS OF ALCOHOL.

17. Alcohol.—Al-co-hol'ics are drinks which contain alcohol, like beer, cider, wine, rum, etc. Alcoholics do not make the bones stronger, or firmer, or better formed.

18. Gout is a painful disease. Over-eating and the too free use of wines often cause gout. The "poor man's gout" is caused by the too free use of beer.

19. Rheumatism (rū'ma-tizm) has for one of its causes the too free use of alcoholics. The recovery from this painful disease is hindered by the use of beer, cider, and sweet wines.

20. Tobacco is now thought to have the effect of stunting the growth of the bones of the children who use it in any form.

(a) **FOR THE TEACHER. Directions for Demonstration.**—Procure from the butcher a part of the thigh-bone and two or three sheep's ribs. Make sections of the former so as to show the covering membrane, the *periosteum*, the hard *outer shell*, the *cancellated* part near the ends, and the oily *central marrow*. (Fig. 3.)

Show the elasticity of bone by bending the rib. Break a bone and show the rough ends which occur in "broken bones."

Take a long bone, as a sheep's rib, and put it in a vessel containing one part of muriatic acid and seven parts of water. Allow it to remain a few days. The earthy matter will be mostly dissolved out. The bone will now be flexible, and may be knotted. Place another bone in the fire. The animal matter is expelled, and the brittle "bone-earth" alone is left.

(b) **Directions for Dissection.**—Procure the fore-leg of a calf or ox. Remove

all muscle, fat, and connective tissue from about the joint. Observe the lateral, anterior, and posterior *ligaments*, if it is a "hinge-like joint." Saw the bone off about two inches below the joint. Then saw through the middle of this bone, the joint, and the upper bone, laying open the parts, as in Fig. 4. Note the investing membrane, the *periosteum*; the *compact* bone; the *cancellated* or open-work bone, near the joint; the soft, red, oily *marrow*; the *enlargement* and processes for muscular and ligamentous attachment, near the joint; the *cartilage* tipping the bone; the lateral firm, white, band-like *ligaments*; the white, viscid *synovial fluid*; and, perhaps, an internal *round* ligament, *movable cartilage*, and a mass of *fat*. Cut the lateral ligaments. Observe the smooth, moist surface, the internal layer of *synovial membrane*. Shave off a bit of bluish-white, translucent cartilage and compare it with a bit of bone.

QUESTIONS.

The Bones.

4. How many bones in the body? How held together? 5. Describe bone. How made up? 6. What do ligaments resemble? Of what composed? 7. What are the uses of bones? 8. What are flexible? What leads to deformities? Hence?

The Joints.

9. Mention some joints. What is a joint? 10. Where is cartilage found? What is it? 11. What secretes sy-no'vi-a? What is synovia? 12. Mention the uses of the parts of joints. 13. Write the summary of a joint. 14. Mention the coverings of the framework.

Hygiene of the Bones.

15. Why should a person strive to keep erect? 16. What results from carrying burdens on the head?

Injurious Action of Alcohol and Tobacco.

17. Mention some alcoholics. How do they affect bone? 18. Mention some causes of gout. 19. Speak of alcohol and rheumatism (rū'ma-tizm). 20. What is the action of tobacco on bone?

CHAPTER III.

THE MUSCLES.

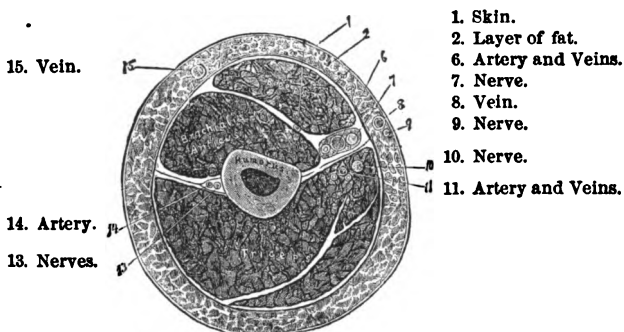


FIG. 5. *Section of Arm.*—Showing the cut skin, fat-layer, muscles, and bone (Humerus).

21. The Muscles make up nearly one-half of the weight of the healthy body. Most muscles occur in pairs,—that is, one on the right resembles one on the left side. (Fig. 1.)

22. Tendons.—Most muscles commence and end in white, firm cords, called *ten-dons*. (Fig. 7, 4, 5.) Tendons do not shorten, do not stretch.

Examples.—Tendons may be felt under the skin about the wrist; also about the ankle and foot.

23. Kinds of Muscles.—There are two kinds :
(1) Those under the control of the will (*vol'un-*

ta-ry) and (2) those not under the control of the will (*in-vol'un-ta-ry*).

24. Outside Muscles.—The muscles outside of the frame-work are of the first kind. They make up the lean meat of the body of man and animals (*a*).

25. Inside Muscles.—The second kind of muscles are mostly found inside the frame-work, as in the heart, in the walls of the blood-tubes, in the walls of the stom-ach, bowels, etc.

26. Fat is made up of little globes of oil. (Fig. 6.)

27. Uses.—Fat rounds out the outlines of the body. It forms a heat-keeping layer under the skin. It is a reserve store of food.

Observation.—When a sick person takes no food he becomes thin. This is because the fat in all parts is used to feed the body.

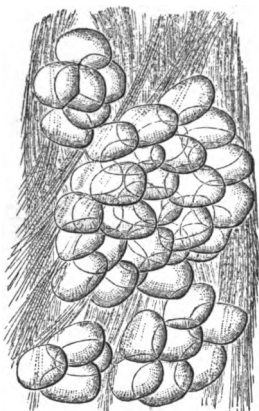


FIG. 6. *Fat-Cells.*

HOW MUSCLES ACT.

28. Muscle-Work.—The function of muscle is to *contract*. Rubber is elastic, but, unlike muscle, it has not the power of self-shortening.

29. Action of Muscle.—When muscles contract,

the part to which they are attached must move. Thus when we cause the *biceps of the arm* (Fig. 7, ³) to swell up, then the fore-arm is moved (owing to the hinge-like joint of the elbow) towards the arm (*d*).

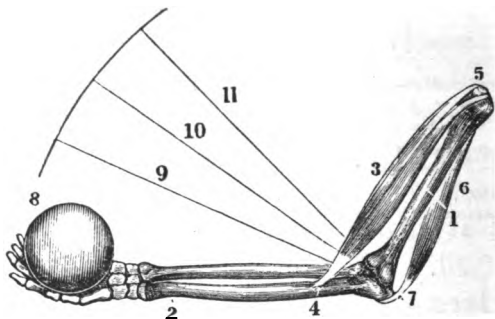


FIG. 7. *Action of Muscles.*—1, The bone of the arm above the elbow. 2, One of the bones below the elbow. 3, The muscle that bends the elbow. This muscle is united, by a tendon, to the bone below the elbow (4); at the other extremity, to the bone above the elbow (5). 6, The muscle that extends the elbow. 7, Its attachment to the point of the elbow. 8, A weight in the hand to be raised. The central part of the muscle 3 contracts, and its two ends are brought nearer together. The bones below the elbow are brought to the lines shown by 9, 10, 11. The weight is raised in the direction of the curved line. When the muscle 6 contracts, the muscle 3 relaxes and the fore-arm is extended.

30. Voluntary Movements.—By the proper working together of the outer muscles we can move our body, and we can make useful movements of arms, hands, feet, lips (walking, grasping, hand-working, chewing, talking).

31. Involuntary Movements.—The muscular fibres of the in-tes'tines force the intestinal contents along; the contractions of the heart-muscles force

the blood into and through the blood-tubes. These movements go on while we are talking, reading, thinking, or sleeping. The vital movements of the body are carried on by the involuntary muscles.

(a) **FOR THE TEACHER. Directions for Demonstration.**—Conduct the class to a butcher's shop. Call their attention to a section of the middle of the thigh from which "round-steak" is sliced. Point out the central-placed *bone*: its hard, white *outer ring of bone*; its soft, oily, blood-stained *marrow*, and its firm investing membrane, the *periosteum*.

On the cut surface of the meat, note: the separate *muscles*; the *fibres* making up a muscle; the white *connective tissue* separating each muscle or group of muscles; the open, round entrance to the *arteries*; the collapsed entrance to the *veins*; the white section of a *nerve*; the streaks of *fat* between the muscles; the white, firm membrane enveloping the thigh, the *fascia*; the outer layer of *fat* and the shreds of *connective tissue* which hold the *skin* in place. (See Fig. 5.)

(b) **Dissections.**—If it is not convenient to visit the butcher's, then secure the hind-quarter of a fresh rat or rabbit. Freeze it hard. (In warm weather use ice and salt.) Make a clean cut around the middle of the thigh, cutting through the skin and fat. Now, using a fine-toothed, sharp, cold saw (working in a cold room), cut through the muscles and bone. Clear off the dust. Point out the parts as in the previous demonstration (a).

(c) **Microscopic Work.**—Secure small bits of fat, muscle, and connective tissue. In a shallow dish, and under water, with needles in handles carefully pick a bit to pieces. Put the smallest piece on a clean glass slide, add a drop of water, cover, and examine with a half-inch objective. Call attention to the difference between muscle and fat and muscle and connective tissue. Note that the fibres of red meat have little cross-lines. The "inner muscles" do not have these cross-lines.

(d) **Personal Work.**—Request each member to bare the arm, even to the shoulder. Ask them to vigorously open and close the hand a number of times. Call attention to the alternate hardening and softening of the *muscles* of the forearm (front and rear) during the movements; to the tense cords lying under the skin over the space above the wrist, the *tendons*, and to the overfulness of the blue *veins* due to the exercise. Call attention to the *antagonistic action of the biceps and triceps* (Fig. 7) of the arm during "showing the muscle" and straightening the arm.

QUESTIONS.

The Muscles.

21. What is the weight of the muscles? How do we find them? 22. Describe tendons. In what are they peculiar? Where located? 23. How do muscles differ? 24. Tell about the vol'un-ta-ry muscles. 25. Where are the in-vol'un-ta-ry muscles found? 26. What is fat? 27. Mention the uses of fat. What is often noticed?

How Muscles act.

28. What is the function of muscle? How does it differ from rubber? **29.** What do contracting muscles do? Illustrate. **30.** What do the voluntary muscles enable us to do? **31.** Mention some movements which go on during sleep. Why are involuntary muscles essential?

CHAPTER IV.**HYGIENE OF BONE AND MUSCLES.****CONDITIONS FOR HEALTH.****32. How to become Vigorous:**

You must eat simple, good food.

You must breathe pure air.

You must keep the system clean.

You must use your muscles regularly.

You must not overtax your muscles.

You must not use alcohol or tobacco.

33. Food.—The growing boy or girl must have plenty of *bone-making food*. This food is best supplied by fresh milk from a healthy young cow; by well-cooked whole-wheat foods, oatmeal, and barley; and by fish and eggs in moderation.

34. Working-Foods.—For sustained work milk, oatmeal-porridge, whole-wheat bread, Indian-corn

bread, cracked-wheat, butter, and fish occupy the first place. Adults can with safety add to this list beef, pork, ham, and cheese.

35. Air.—Work and exercise is of most advantage to the body when it is taken out-of-doors.

36. Cleanliness.—The vigorous may take a cold bath daily. All others must keep the skin clean by using warm water, soap, and much rubbing (*a*).

EXERCISE AND ITS CONDITIONS.

37. *The object of muscular exercise is to make a uniformly strong body.* Such exercises should be practised as will develop the weaker parts. To do good, muscular exercises should be regular and graded.

38. *Garden-work and house-work take the first rank.* Sports (running, tree-climbing, swimming, riding, ball, cricket, and lawn-tennis) are excellent. Gymnastics (*jim-nas'tiks*) and out-of-door dancing are only less excellent.

39. *The exercise-suit ought to be of flannel.* All garments should be loose, especially about the neck.

The *shoes* should be roomy and long, for the foot broadens and lengthens with each vigorous step. The heels ought to be low and broad. The soles should be thick enough to keep the foot dry and warm.

40. *Hot milk, or cool water, may be sipped at*

intervals during severe exercise. "Small quantities, and often," should be the rule. Food ought not to be taken just before or just after exercise.

EFFECTS OF ALCOHOL AND TOBACCO.

41. Alcohol.—Students and athletes when training for severe exercises, as a boat-race, cease using beer, wine, or spirits. Their trainer knows that they can do their work better and easier without them. For the same reason the trainer forbids the use of tobacco.

42. Action of Alcohol.—*In large drams* it causes the muscles to work improperly and out of their proper order (in-tox-i-ca'tion). *Large amounts* cause an entire loss of control over the outside muscles ("dead-drunk" state).

43. Alcoholics used constantly and for very long times often cause many fibres in the muscles to change to fat. Fat cannot contract. When the fibres of many muscles become fatty the entire body shows weakness.

44. Alcohol does not feed the bones. It does not build up the contracting part of the fibres of muscles.

45. Tobacco does not feed the bone or the muscle. It does injure the blood and the bone-food and the muscle-food carried in the blood.

In growing children and youth it slows body-

growth. It prevents the muscles from working properly. It weakens the entire body.

46. Children and growing persons, certainly, should abstain from the use of alcoholics (90) as well as of tobacco.

(a) A free movement from the bowels must be secured daily. Ripe fruit daily is excellent for this object. A glass of cold water taken on rising in the morning is useful.

QUESTIONS.

Conditions for Health.

32. What is essential in order to become vigorous? **33.** What food is essential? How supplied? **34.** Mention food suitable for workers. **35.** Where should exercise be taken? **36.** How may cleanliness be attained?

Exercise and its Conditions.

37. What is the object of exercise? Hence? **38.** Mention the best kinds of exercise. **39.** Speak of the exercise-suit; of shoes. **40.** How should drink be taken? When?

Effects of Alcohol and Tobacco.

41. Who cease using alcoholics and tobacco? Why? **42.** What is the effect of large drams? of large amounts? **43.** What change is caused by alcohol? What results? **44.** What can alcohol not do? **45.** Is tobacco a food? What evil may it do? **46.** Who should be abstainers?

CHAPTER V.

THE SKIN.

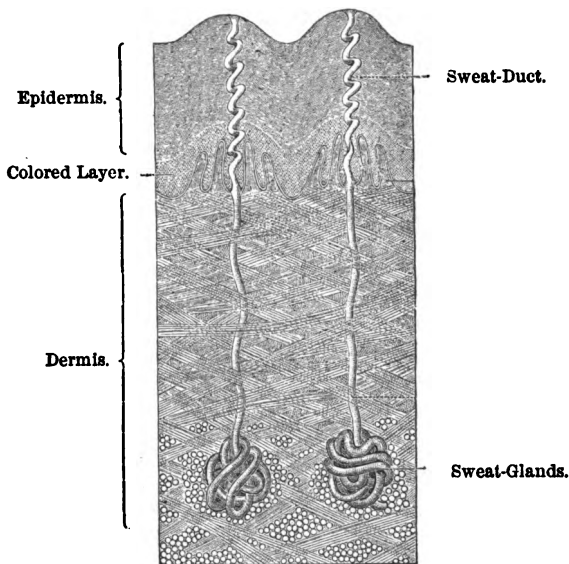


FIG. 8. Vertical section of the skin of the forefinger across two of the ridges of the surface

47. The Skin is the outer covering of the body. It is soft, oily, and smooth (*a*).

48. Skin-Layers.—The skin is made up of two layers. The outer-layer is called *epi-der'mis*; the inner-layer the *der'mis*.

49. The Outer-Layer is horny. When cut it does not bleed, for it has no blood-tubes (c). Its under surface contains the coloring-matter of the skin. (Fig. 8.)

50. The Inner-Layer contains blood-tubes, nerves, minute muscles, hairs, oil-glands, sweat-glands, and fat-cells. (Fig. 9.)

51. Summary.—The *skin* is made up of

{	Outer-layer
	(Ep-i-der'mis),
	Inner-layer
	(Der-mis).

52. Functions of the Skin.—It protects the body. It prevents poisons and the germs of disease from entering the body. It contains the nerves of touch. (Fig. 9.)

SKIN-INJURIES.

53. Upper-Layer Injuries.—When you “scrape off the skin” you usually tear off a little of the outer-layer only. The “raw-spot” is the sensitive, exposed, inner-layer. When the “raw-spot” heals over no scar is left.

54. Precaution.—Before handling poisons (quicksilver, active dyes) or dead bodies, carefully seek all scratches, bare-spots, or hang-nails. Cover them with sticking-plaster. Then smear the hands, wrists, and fore-arms with lard or oil. If you do not do so you may be severely poisoned.

55. Inner-Layer Injuries.—When a person is severely cut or deeply burnt (*d*), then the inner-layer as well as the outer-layer of the skin is destroyed. When such a wound heals a scar always remains. A scar is a patch “set in” in the inner-layer.

HYGIENE OF THE SKIN.

56. *The skin should be kept clean.* Strong, harsh soaps ought not to be used. The daily rubbing of the skin with a coarse towel or a flesh-brush will increase its vigor.

57. *Alcohol in the blood interferes with the healthy feeding of the skin.* The continued use of beer, cider, wine, or spirits tends to make the skin harsh and coarse. The excessive use of alcoholics often induces pimples, blotches, and stains.

58. *Tobacco, especially when used by children and young people, quite often makes the skin appear old, yellow, and sallow.* Cigarette-smoking is especially injurious to the skin.

CLOTHING.

59. *Three-fourths of the heat set free in the living body is lost by the skin.* In cold weather clothing serves to retain the heat of the body. In hot countries it is used to prevent scorching of the skin.

60. *Woollen garments are safer than cotton or linen for constant wear.* All under-garments and

night-garments should be made largely of wool or silk.

61. *Loose-fitting clothing is both warmer and cooler than close-fitting clothing.* It is better to suspend the clothing from the shoulders rather than from the waist.

62. *The night-clothing should be thicker than that worn during the day.* (1) The night is cooler than the day ; (2) the loss of heat from the body is greater during the sleeping than the waking hours.

63. *Waterproof clothing should only be worn to keep out the wet.* "Rubbers" should never be worn in-doors or during dry weather.

64. *Do not sit in damp clothing.* When you get dampened, keep in motion until you can change your clothing. The sheets and the clothes from the wash should always be sunned or well warmed before being put in use.

65. *A change of clothing from thick to thinner should only be made in the morning.* The evening hours demand an increase of clothing because (1) of the increasing coolness and dampness, and (2) because of the more weary condition of the body.

66. *It is not safe to wear light, gauzy garments at balls or parties occurring late at night.* Many young ladies date their decline in health from a certain party. It is dangerous to wear thin, close-fitting shoes in cold or damp weather.

(a) **FOR THE TEACHER. Directions for Demonstration.**—Call attention to the oily, flexible, elastic *surface*; the *creases*; the *pits*; the varying *thickness* (palm of hand, sole of foot, between the fingers, the outer and inner parts of the arm, etc.); the *upper-layer scales* (scurf); the *dandruff* of the scalp; the varying *color*; the *oil*; the *moisture*; the *body-hairs*.

(b) With a magnifying-glass seek the *sweat-pores* on the tip of the fingers and study the exuding drop. Place a few *hairs* under the microscope, also a few sections of hair from the paper of a man who has just shaved. Note the *oval cross-section*, the *shingle-like imbrications* of the hair's outer surface with the free ends looking towards the point of the hair, and the *pith* of the hair.

(c) A *corn* is a small, hard portion of the thickened outer-layer. A *freckle* is an increase in spots of the coloring-matter. In a *blister*, water from the blood gathers between the inner- and outer-layers. The *scurf* is made up of dead scales of the upper-layer. When the *upper surface* wears off the middle-cells are pushed up by the under, newly-made cells.

(d) **Management of a Burn or Scald.**—In a small burn apply cold water continuously until the smarting ceases. If severe, prick the blisters (do not pull away the upper-layer) and apply cloths wet with water containing cooking soda or strong soap-suds. Send for the doctor.

QUESTIONS.

The Skin.

47. What is the skin? 48. Describe the skin. 49. Speak of the outer-layer; of the color-layer. 50. What is found in the inner-layer? 51. Write out the skin-summary. 52. What are the functions of the skin?

Skin-Injuries.

53. Speak of upper-layer injuries; of the raw-spot. 54. What pre-cautions should be taken? Why? 55. Speak of inner-layer injuries. What is a scar?

Hygiene of the Skin.

56. What encourages cleanliness and vigor of the skin? 57. What is the action of alcohol? of continued use? of excessive use? 58. How does tobacco injure the skin?

Clothing.

59. What passes from the skin? For what is clothing used? 60. Why are woollens to be preferred? 61. Why wear loose-fitting clothing? What is preferable? 62. Why should night-clothing be thick? 63. When should rubber not be worn? 64. When wetted, what should you do? What should be dry? 65. Why is the morning suitable for a change of clothing? 66. Mention some unsafe and dangerous customs.

CHAPTER VI.

ORGANS IN THE SKIN.

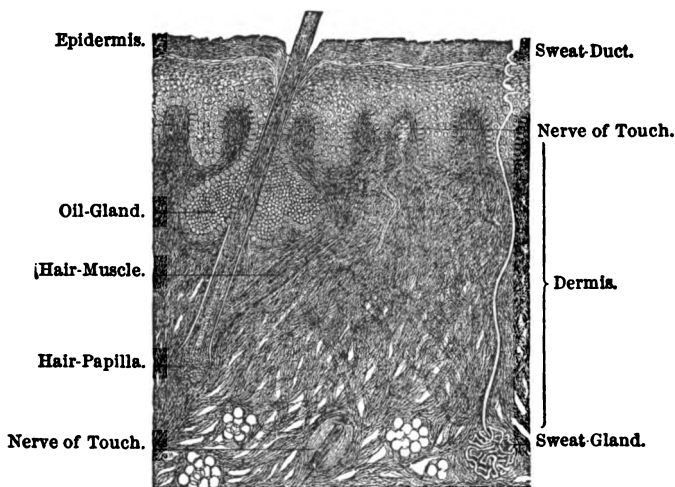


FIG. 9. *Vertical section of normal skin. (Highly magnified.)*

THE NERVES OF TOUCH.

67. Touch gives us knowledge about things with which we come in brief contact. The nerves of touch are protected by the outer-layer of the skin. (Fig. 9.)

68. Uses.—The sense of touch acts to give us warning about injurious things, as hot, or cold, or

sharp objects. It enables us to learn of the size, form, and nature of objects found in the dark.

69. Alcohol in small doses acts in many to lessen the keenness and delicacy of touch. When used in excess the sense becomes very much dulled.

THE HAIR.

70. Hairs are found on most parts of the body. They have their seat in pits in the skin (Fig. 9), and grow on the *hair pa-pil'lae*.

71. The Function of the hair is to protect exposed parts, as the head, face. A hair only grows in length, not in bulk.

72. Muscles of the Hair.—Most hairs have a minute muscle (Fig. 9). When the muscle is excited (cold, fright, electricity) it contracts and the hair "stands on end."

73. The Oil-Glands are found in most parts of the skin (Fig. 9). The oily secretion keeps the hair glossy and the skin supple.

74. Care.—The oil-ducts become clogged with dust. Dust and dirt gather on the hair and scalp. Hence the head should be occasionally washed and frequently brushed.

75. Hair-oils are *offensive and are not needed*. *Cos-met'ics* often contain injurious agents (lead, quick-silver, bismuth). Such agents injure the texture, softness, and vigor of the skin.

THE NAILS.

76. The Nail is a changed part of the upper-layer of the skin. It is smooth, flexible, and horny.

77. Uses.—The nail protects the sensitive finger-tips, and aids the finger-tip in picking up small objects.

78. Care.—It is better to file the nails rather than to pare them with a knife or to snip them with scissors. Dirt is best removed with a quill tooth-pick and the nail-brush.

THE SWEAT-GLANDS.

79. The Sweat-Glands are seated deep in the skin (Fig. 8 and Fig. 9). They set free from the blood a fluid called the per-spi-ra'tion.

80. The Quantity of the Perspiration ranges from two to four pints daily. The amount is greater in warm than in cold weather.

81. The Functions of the sweat-glands are (1) to cool the body (*a*), and (2) to remove water and certain wastes from the system.

82. Summary.—The *organs* seated in the skin are

	{	Nerves of Touch,
		Hair-Papillæ,
		Oil-Glands,
		Sweat-Glands.

CARE OF THE SKIN.

83. *Damp clothing is dangerous.* Wet clothing and wet shoes convey the heat too rapidly from the skin. Avoid a damp bed, a damp, musty-smelling room, a damp house, and a damp location for a house.

84. *Dampness is often as much of an enemy to health as filth.* Dampness of the home is a great cause of early *con-sump-tion* and of *rheumatism* (ru'-ma-tizm).

85. *Avoid sitting in a current of air when heated or freely perspiring.* Do not sit or lie on the damp ground.

BATHING.

86. *A clean skin relieves the lungs and kidneys of extra work.* It favors the keeping of health and the strengthening of the body and the mind.

87. *"Daily bathing, from childhood to old age, should be the rule"* (BOWDITCH). Bathing imparts tone and vigor to the brain and internal organs, as well as to the muscles and skin.

88. *The face and head should be wet with cold water before entering the bath.* Cold-baths, river-baths, and sea-baths ought only to be taken in the morning hours. Do not bathe directly after eating or when heated.

89. *Sea-bathing is valuable for persons in fair health.* It should not be indulged in by infants, the

elderly, and most feeble persons. Keep salt water out of the mouth and ears.

Exercise should follow the sea-bath, as well as other baths (*b*), the *warm evening bath* excepted.

(a) **Experiment.**—Place a few drops of alcohol or of cologne on the skin. It rapidly disappears (e-vap'o-rates) and the skin feels cooler. Place a few drops of water on the skin. The same results take place, but slower. In both cases some of the heat of the skin was taken away in order to convert the fluid into a vapor. The same occurs at or near the mouths of the 2,400,000 sweat-ducts when the glands are in health. By this process the heat of the body is rapidly passed away.

(b) **Treatment of a Drowning Case.**—(1) **ACT AT ONCE.** *Raise the body so that the water will run from nose and mouth. Wipe mouth and nose. Loosen the clothing. Lay the person on the back. Two persons, standing to the right and left of the patient, pass the right hands under the waist and lock hands; now raise the body until the heels and head alone touch the ground; count fifteen rapidly; then lower the body flat to the ground, and press the elbows to the side; count fifteen rapidly; then raise the body as before; count, lower; and so on alternately, raising and lowering. Allow head, arms, and legs to dangle freely.* (FRANCIS'S METHOD.)

(2) *Persevere for half an hour to an hour. As soon as the natural movements of the breathing recommence, cease the Francis movements.*

(3) *Maintain the temperature of the body by friction, hot bottles, and warm blankets. Keep the head in a current of fresh air.*

(4) *As soon as the patient can swallow, give warm milk, tea, or coffee containing a little ammonia (spirits of hartshorn). Put the patient in a warm bed. Pack hot-water bottles about him. Encourage sleep. Keep the windows open.*

QUESTIONS.

The Nerves of Touch.

67. What is touch? What protects its nerves? 68. What is the use of touch? 69. How does alcohol affect touch?

The Hair.

70. Where are hairs found? 71. What is the purpose of the hair? 72. What do hairs have? What may happen? 73. What glands exist in most parts? What is the use of the oil? 74. Why should the hair be cleaned? 75. Mention objections to hair-oils; to cos-met'ics.

The Nails.

76. What is a nail? 77. Of what use are nails? 78. How should nails be cared for?

The Sweat-Glands.

79. What are deep-seated? What is per-spi-ra'tion? 80. How does the amount of perspiration vary? 81. What are the duties of the sweat-glands? 82. Write out the organs-of-the-skin-summary.

Care of the Skin.

83. Why is damp clothing dangerous? What should be avoided? 84. Why is dampness a human enemy? 85. What should be avoided?

Bathing.

86. How does a clean skin favor health? 87. Give Dr. Bowditch's maxim. What results from bathing? 88. What care should be taken in bathing? 89. Who may take sea-baths? What should follow baths?

CHAPTER VII.

NARCOTICS AND STIMULANTS.

NARCOTICS.

90. Common Alcohol (*a*) is the agent in *pure* beers, ciders, wines, and spirits which causes the bad effect of those drinks.

91. Alcohol (*b*) is largely made in the United States from corn. Alcohol and water mix readily.

92. Medicine.—First quality alcohol is safer for medicine than wines or spirits. (1) It is pure. (2) It can be more accurately dealt out. (3) It is not so tempting to the taste.

93. Alcoholics are of two kinds; *fer-ment'ed*, like beer, cider, and wine, and *dis-tilled'*, like rum, brandy, gin, and whiskey.

94. Fermentation.—By the action of a yeast (fer-ment) apple-juice becomes *cider*; grape-juice becomes *wine*; fruit-juices become *fruit-wines*; and malted barley with hops becomes *beer*. They all contain alcohol.

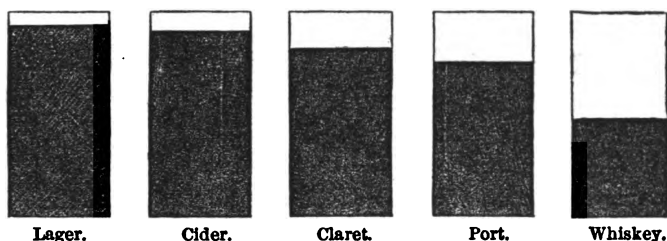


FIG. 10. The white space shows the proportion of alcohol in each of the measures.

95. Distillation.—If cider is heated in a “still,” *cider-brandy* is distilled over; if wine, *brandy*; if fermented molasses, *rum*; if fermented corn, or rye, *whiskey*. These liquors are rich in alcohol (Fig. 10). They are called *spirits*.

96. Chloral (klo-ral) is made from alcohol. In proper doses it induces rest and sleep. It causes the “chloral-habit.”

97. Opium.—This drug is made from the juice of the poppy. The best opium comes from Turkey (*f*).

98. Uses of Opium.—It is the best drug we

now have to relieve pain. It not only quiets pain, but to many it gives mental delight. Persons who learn to like it often become enslaved to the use of the drug (*Opium Habit*).

99. The Opium Habit deeply injures the mind and the body. This is well seen in the degraded Chinese opium-smoker.

100. Opium Preparations (*f*) should not be used except when the doctor orders them from day to day.

101. Narcotics.—Alcohol, chloral, and opium belong to the same class of drugs. They are *narcotics* (*g*).

MOTOR-DEPRESSANTS.

102. Tobacco.—The tobacco-plant was found in Virginia. Chewing, snuffing, and smoking compounds are largely made from the dried and prepared leaves of tobacco.

103. Nicotin.—The leaves of the tobacco-plant contain several active drugs. The most powerful and most dangerous one is the *nic'o-tin*. Nicotin is a poison which acts like Prussic acid.

104. *No young person should use tobacco.* The younger and the feebler the person the more injurious are the actions of the active drugs of tobacco. Minute doses taken daily, as by smoking, slowly injure the youthful system.

STIMULANTS.

105. Coffee is the seed of a plant growing in Java, Costa Rica, Brazil, and other hot countries. Coffee contains an exciting drug called *caffé-in*.

106. Tea is the dried leaves of plants which are largely cultivated in China, Japan, and India. Tea-leaves contain an exciting drug exactly like *caffé-in*.

107. *The active drugs of tea and of coffee act to spur nerve-action.* They do not feed and strengthen the body any more than the whip adds strength to the horse.

108. Quinia (kwin'ee-ah) is derived from the bark of trees largely cultivated in Java, India, and South America. It acts to spur nerve-action.

It is useful in malaria (ma-lay'ree-ah). Its common use as a "pick-me-up," as a "cure-all," as a "home-stimulant" is bad and harmful.

109. Mustard, Pepper, and Spices.—These "ap'pe-tiz-ers" have no feeding value. They each contain peculiar, active drugs. These drugs make some foods taste better. They encourage persons to eat more than is really needed. *The "appetizers" should not be used by children and youth.*

110. A Stimulant acts like a spur. Tea spurs the brain. Pepper spurs the stomach. Spices spur the glands about the mouth. A stim'u-lant does not give strength, or force, or heat to the body.

III. Summary.—

<i>Nar-cot'ics.</i>	{ Alcohol, Chloral, Opium.
<i>De-pres'sant.</i>	Tobacco.
<i>Stim'u-lants.</i>	{ Coffee, Tea, Quinia, Mustard, Pepper, Spices.

(a) **Fusel Oil.**—"Ethyl-Alcohol" is the scientific name of common alcohol. "Raw" alcohol, some "made drinks," and many "drugged alcoholics" contain a very exciting and poisonous alcohol known in chemistry as *Amyl Alcohol*, or "fusel oil." Many true alcoholics are "fortified," and thus made much more actively and destructively injurious to the body, by the addition of corn-alcohol or potato-alcohol.

(b) **FOR THE TEACHER. Properties of Alcohol.**—Show to the class a specimen of good alcohol. It is a clear, *colorless fluid*. It *cannot be frozen* by common means. It *rapidly evaporates*, as from the hand. Its *drops are small*—about half the size of drops of water. It has a peculiar, *characteristic odor*. It *readily burns*, producing little light, no smoke, and much heat, and leaves no ash,—that is, it readily unites with the oxygen of the air when set on fire and changes to vapor of water and carbonic acid gas. If some is taken into the mouth, it produces a burning, warming sensation; if it is swallowed, the sensation is felt even to the stomach.

(c) **Tests for Alcohol.**—If an alcoholic contains less than one-half of water it will ignite. If an alcoholic is distilled, the fluid which first comes over will have the odor and taste of alcohol and will readily ignite. If a fluid contains alcohol the addition of the *chromic-acid test* (potassium bichromate, one part, pure sulphuric acid, three hundred parts) will produce, after a time, an emerald-green color.

(d) **Uses for Alcohol.**—To make, prepare, and preserve drugs; to make "patent medicines"—as tonics, bitters, etc.; to make perfumes, varnishes, vinegars; to make chloral, chloroform, and ether; to aid in the making of rubber goods, many fabrics, jewelry, etc. Nearly half the alcohol made in the United States is used in the arts and industries of our country.

(e) **Demonstration.**—Exhibit to the class specimens of the common alcoholics. If convenient, test the presence of alcohol. Exhibit specimens of opium, morphia, tobacco, spices, etc., allowing the pupils to handle, smell, and taste. Call their attention to the proper use for these agents derived from nature or made by the art of man.

(f) **Opium Preparations.**—*Morphia* (mor'fe-ah) is a white powder taken out of crude opium. *Laud'a-num* is an alcoholic preparation of opium. Most "*soothing syrups*" contain morphia—and often dangerous amounts of that drug. The majority of commercial "*cough medicines*" are rich in opiates.

(g) **Action of Narcotics.**—At first narcotics excite the brain. Later, the brain-action is dulled. In large doses they overcome brain-action and cause deep, stupid sleep. Sometimes they cause dangerous, death-like sleep.

QUESTIONS.

Narcotics.

90. What liquors contain alcohol? 91. From what is alcohol largely made? 92. Why is alcohol safer than wines or spirits? 93. What two kinds of alcoholics? Mention examples. 94. What results from fer-men-ta'tion? 95. What is made by dis-till-la'tion? Name some spirits. 96. From what is chloral made? What may it do? 97. What is the source of opium? 98. What good effect from opium? bad effect? 99. What is the "opium-habit"? Where seen? 100. How may the "opium-habit" be prevented? 101. Name the common nar-cot'ics.

Motor-Depressant.

102. What are largely made from tobacco-leaves? 103. What exists in tobacco? What is peculiar about nic'o-tin? 104. Why should the young not use tobacco?

Stimulants.

105. What is the source of coffee? What does it contain? 106. Mention sources of tea. How does it resemble coffee? 107. What is the action of the tea- or coffee-drugs? 108. Give sources of quinia (kwín'ee-ah). When is it useful? hurtful? 109. Name some ap'pe-ti-zers. What is their action? Hence? 110. Mention some spurs. What do stim'u-lants lack? 111. Write out the narcotic stimulant summary.

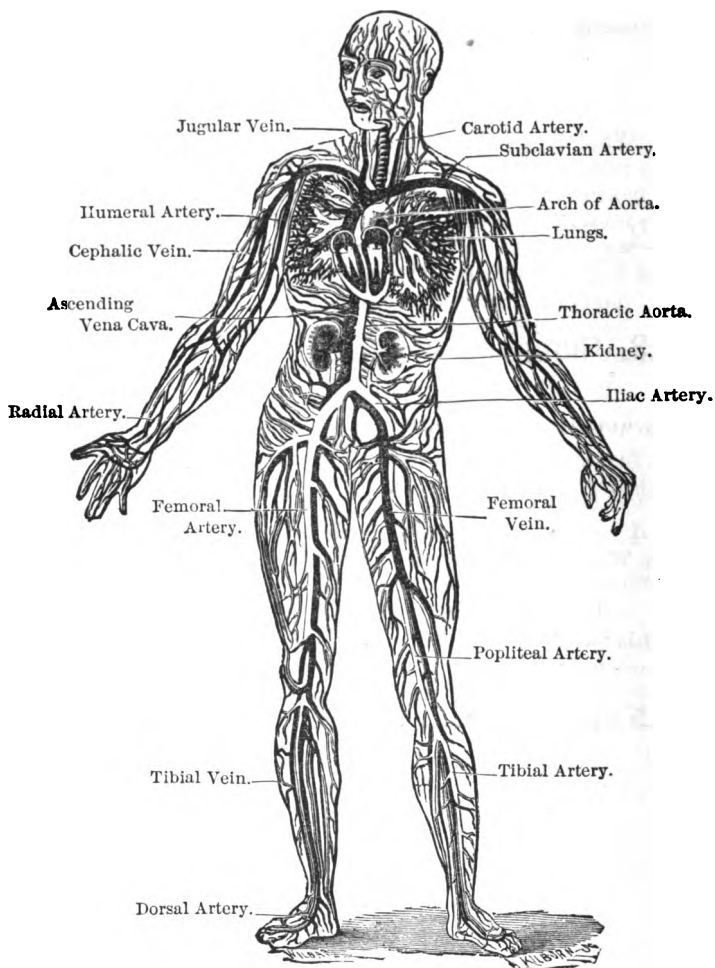


FIG. 11.

CHAPTER VIII.

THE BLOOD.

112. The Blood is found in all parts of the body. You cannot prick the soft parts of the body without setting free blood (*a*).

113. Composition.—The blood is the red-fluid of the living body. It is made up of a clear fluid, the *plas'ma*, and many round disks (red and white) called *corpus-cles* (kor'pus-ls).

114. Clotting.—The blood in the living body is always fluid. If it escapes from the blood-tubes it becomes semi-solid,—that is, it clots.

115. Use of the Clot.—If you are cut, then the blood trickles out, perhaps it comes out in jets. If it is a small wound, the blood soon clots in the cut tube and the wound. The blood-clot forms a plug. The plug stops the bleeding (*b*).

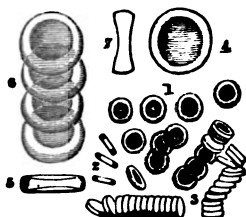


FIG. 12. *Blood-corpuscles.*

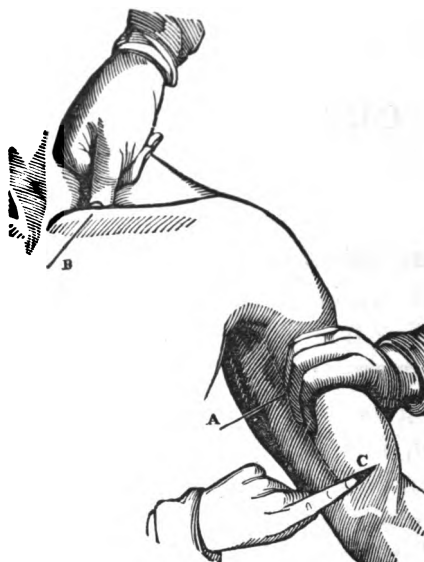


FIG. 13. *The manner of compressing divided arteries.*—A, Compressing the large artery of the arm with the fingers. B, The subclavian artery. C, Compressing the divided extremity of an artery in the wound with a finger.

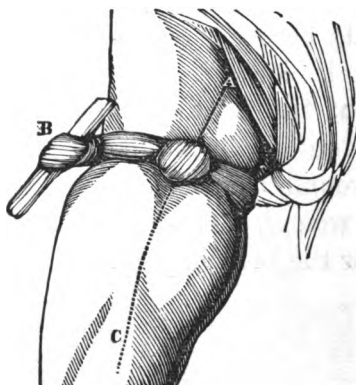


FIG. 14. *The method of applying the knotted handkerchief to make compression on this artery.*—A, C, The track of the large artery of the arm.

(a) **FOR THE TEACHER. Examination of the Blood.**—Place the microscope in a good light. Put in the middle-length eye-piece and the one-fourth inch objective. Clean and warm several glass slides and covers. Prick the finger. Transfer a minute drop of blood to the centre of three slides. After spreading, allow one drop to dry. At once cover the other drops.

Place slide No. 1 on the stage, focus, and note: a pale fluid, the *plasma* and numerous disks, the *red corpuscles*. Perhaps you may see a larger, round mass, whiter in color, irregular at the edges, and granular in appearance, a *white corpuscle*. The red are about $\frac{1}{250}$ of an inch in diameter and $\frac{1}{1000}$ in thickness. Later, examine the other slides, noticing differences. (Fig. 12.)

(b) **How to Stop Bleeding.**—*Let the wounded person lie down. Raise the cut part and hold it up. If the CUT IS SMALL, clean the wound with water and expose it to the air; or apply cold water; or apply hot water (as hot as can be borne). This will control the bleeding.*

(c) *If the CUT IS LARGE, hold your fingers on the jetting points in the wound. Have a friend tie a twisted handkerchief loosely around the arm, or leg, on the body-side of the cut. Put in a small stick and twist (Fig. 14) until the bleeding stops. Remove your finger from the wound and send for a doctor. Keep the wounded person quiet. Give the patient water, or hot milk, or hot coffee, BUT NO ALCOHOLICS.*

QUESTIONS.

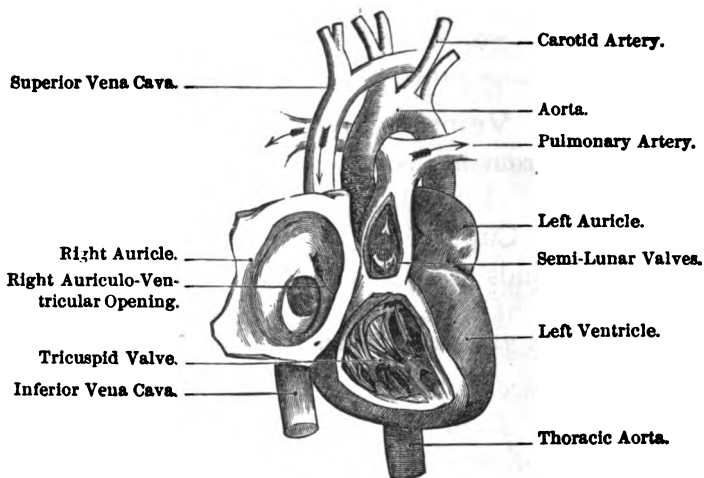
The Blood.

112. Where is the blood found? 113. What is the blood? How made up? 114. How does living blood differ from clotted? 115. How does blood come from a wound? What stops the bleeding?

CHAPTER IX.

THE CIRCULATORY APPARATUS.

THE HEART.

FIG. 15. *The heart and the great blood-tubes.*

116. The Heart is found in the left side of the chest. (Fig. 21, ⁵.) It is a hollow organ made largely of muscle. It is about the size of the closed fist (*a*).

117. Cavities.—By a partition the heart is divided into a *right* and a *left heart* (*b*). Each half is divided into two chambers called *au'ri-cle* (the upper) and *ven'tri-cle* (the lower). An opening exists between the chambers of the same side. (Fig. 15.)

118. Valves.—At the openings to the ventricles and at the entrances to the large arteries valves are found. (Fig. 15.) The valves permit the blood to flow forward, but not backward (*b*).

THE BLOOD-TUBES.

119. The Arteries are the round, open tubes which conduct the blood from the heart.

120. The Veins are the thin-walled tubes extending in from all points of the body and ending at the heart. (Fig. 11, *the black lines*.)

121. The Capillaries are the minute tubes connecting the ends of the arteries with the beginnings of the veins. (Fig. 20, ⁶, ¹⁴.)

The *cap'il-la-ries* are smaller than fine hairs. Their walls are so thin that the plasma can easily pass back and forth.

122. Position.—The *capillaries* abound in all parts. The *arteries* are usually placed deep between the muscles or under bones. (Fig. 5.) This is for safety. *Veins* run along side the large arteries. They also are numerous just under the skin. (Fig. 5.)

123. Summary.—

The <i>Heart</i> , <i>Ar'te-ries</i> , <i>Cap'il-la-ries</i> , <i>Veins</i> ,	{	hold the blood in the living body.
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124. Duties.—By the action of the *heart* (in the main) the vital fluid (the blood) is kept in mo-

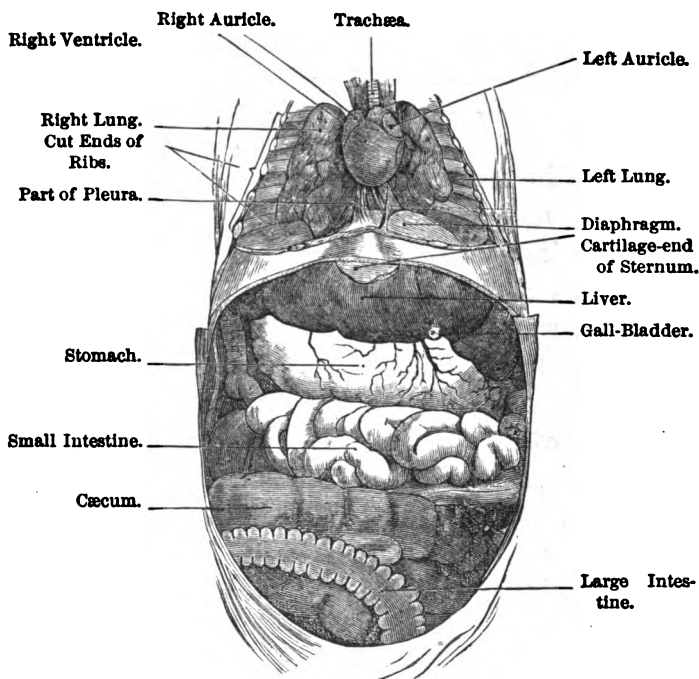


FIG. 16. *The viscera of a rabbit as seen when the cavities of the abdomen and thorax are opened.*

tion. By means of the *blood-tubes* the feeding fluid (the blood) reaches all parts of the body. If the *blood* cannot reach a part, that part soon dies.

CHANGES IN STRUCTURE INDUCED BY ALCOHOL.

125. To the Heart.—If al-co-hol'ics, especially beer, are used in excess for long periods many fibres of the heart-muscle may change to fat.

126. Fatty Heart.—A fatty heart is a weak heart (43). It is unable to do full work. Hence the entire body suffers from its feebleness.

127. To the Arteries.—The long use of alcoholics, in excess, sometimes causes the walls of the blood-tubes to change to fat; at other times to a substance like chalk. Such tubes are weak and brittle.

128. Apoplexy.—When a blood-tube in the brain cracks open, the blood escapes into the brain. This escape causes *ap'o-plex-y*. Persons who have used alcoholics in excess are quite liable to such an accident, because their arteries are not healthy.

THE WORK OF THE LYMPHATICS.

129. The Lymphatics (lim-fat'iks) are a system of fine tubes found in most parts of the body. (Fig. 17.) They end in the large veins at the base of the neck. (Fig. 21, ²⁴.)

130. The Lymphatic Glands are little masses found in the course of the lym-phat'ics. (Fig.

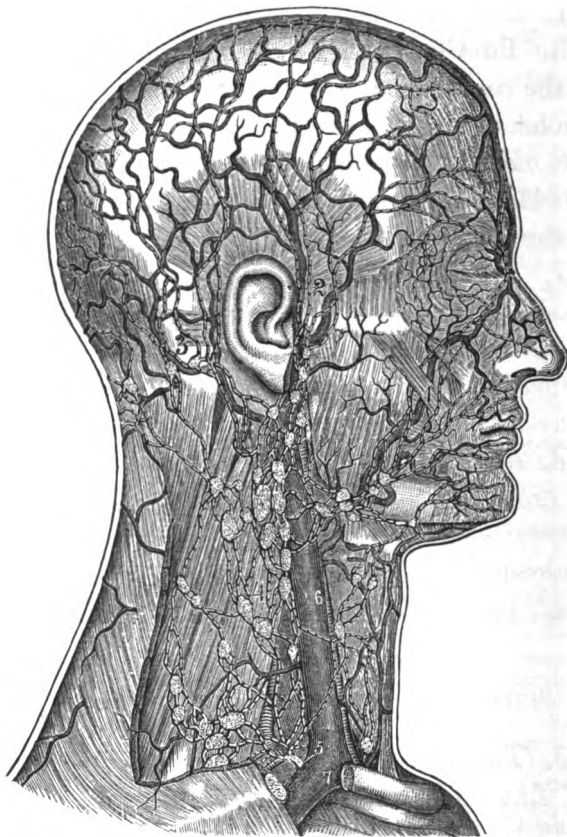


FIG. 17. *The lymphatics of the head.* (The skin and fatty tissues having been removed.)—1, 2, 3, Lymphatics. 4, Lymphatic glands. 6, 7, Veins. (LEIDY.)

17, ^{3, 4, 5}.) In scrof'u-la they are often enlarged and painful.

131. Duties.—The *lym-phat'ics* suck up stray drops of fluid in all parts. They suck digested fats from the intestine. They convey these fluids into the blood.

The *glands* work over and make changes in the lymph (limf) and the fats. They make them fit to enter the blood.

(a) FOR THE TEACHER. **Directions for Dissection.**—Place a dog, rabbit, or rat on its back. Make an incision in the middle line from the lower jawbone to the pubes. Dissect up the skin as far back as possible on each side, and tie it back with threads. The ribbed part thus exposed is the *thorax* (chest), and the soft part the *abdomen*. (Fig. 16.)

The ribs are seen to be connected with the sternum by means of a white, gristle-like material, the *costal cartilages*. Cut through, on each side of the sternum, the white cartilages, making the cut as near the blue hard rib as possible. At the inferior end of the sternum raise the bone and cut away the muscle, the *diaphragm*, which holds it in place. The freed end is now to be raised, freed from its under parts with a few nicks of the knife, turned over towards the chin, and the ligamentous attachments of the sternum to the right and left upper ribs severed.

Dissect the skin and subcutaneous tissues from the neck parts. On the front neck, to the right and left, we see a thin tube holding dark blood, the *jugular vein*. In the middle line cut through the thin muscle and draw it to the right and left. Remove the layers of tissue beneath until you expose the white, ring-like tube, the *trachea*, and the cartilaginous enlargement above, the *larynx*. By drawing the muscles and connective tissue from the trachea, there will be brought into view, running nearly parallel to it, a firm, whip-cord-like tube, the *carotid artery*; near it, thinner tubes, containing dark fluid, the *veins*, and a white, string-like fibre, the *pneumogastric nerve*. If the larynx is followed upward, it is found to end in a musculo-membranous cavity, the *pharynx*. Beneath and to one side of the trachea is to be seen a collapsed tube with thick fibrous walls, the *œsophagus*, which is seen to open into the pharynx above.

Now cut the larynx free from the pharynx, then raise and separate the parts from the œsophagus and the muscles of the neck below, and pull towards the thorax. The trachea will easily be removed from contact with the œsophagus. Put two strings around each jugular vein, about an inch apart; tie them so as to compress the tubes, and sever the veins between the *ligatures*. Sever the carotids; but, as they are empty, ligatures are not needed.

Now observe the contents of the *thorax*,—two lateral compartments, formed by the thin, smooth-surfaced *pleura*, lining the chest-walls, each compartment contain-

ing a shrunken, pinkish-white, spongy organ, the *lungs*, of which the right is the larger. Tie a tube in the trachea, and fill the lungs with air, by blowing into the tube. Notice the deep lines dividing the lungs into *lobes*, and the irregular lines marking *lobules*, situated just under the pleura. Between the lungs is a sac, the *pericardium*, containing fluid and a firm, pear-like, fleshy organ. Projecting and arching into the thorax from the abdomen is seen a muscular and fascia-like partition, the *diaphragm*. The pericardium is attached to this, and should be cut free; but the lungs are not attached to the diaphragm.

Open the pericardium with the scissors. It is seen to contain a small amount of fluid, and to be lined by a smooth, close, serous membrane. Floating in this pericardial fluid is a firm, pear-shaped, muscular organ, the *heart*. Its apex, or free point, is turned towards the ribs, and its broad, tube-attached base towards the back.

Now continue the separation and elevation of the trachea, arteries, and veins, in a mass, down into the thorax. After the large tube, the *aorta*, is cut below its arch, the lungs and the heart can easily be raised out. The *trachea* is seen to divide into two tubes, the *bronchi*, which in turn divide and subdivide as they enter the *lungs*. From the heart are seen tubes, *arteries* and *veins*, running into the lungs in company with the bronchia. Rising from the base of the heart is seen a large, round, gaping tube, the *aorta*, which arches, gives off several branches, among them the *carotids*, and passes downward along the backbone of the animal, where it is called the *thoracic aorta*. This latter gives off many branches to the right and left, and passes out of the thorax through a hole in the diaphragm.

(b) *Dissection of Heart*.—Procure the heart of a sheep, ox, or dog. The front of the heart may be recognized by a groove filled with fat. Hold the heart with the front towards you. The *right ventricle* in your left hand is more yielding, because its walls are thinner, than the *left ventricle* in your right hand. Observe the gaping *pulmonary artery* rising near the middle line, and back of it the large, elastic, tubular *aorta*. Tie a tube in the pulmonary artery and fill it with water. The fluid does not enter the heart, it being stopped by the *semilunar valves*. Test the *aorta* in the same manner. If the valves are uninjured, the water will not pass into the heart.

Lay open the *ascending* and *descending venæ cavæ*. Allow the cuts to meet in front of the right auricle. Note the size of the *venæ cavæ*, the thinness of the walls, and the absence of valves between them and the auricle. Observe the size, form, and thickness of the walls of the *auricle* and its dog-ear appendage. Cut away most of the *right auricle*. Holding the ventricles in the left hand, pour some water suddenly through the opening into the ventricle. The *tricuspid valves* will float up and close the opening. Allow the water to pass out through the *semilunar valves*. Introduce the scissors between two of the folds of the tricuspid valve, and cut a slit through the ventricular wall to the apex, then turn the scissors and cut alongside of the septum towards the pulmonary artery. Observe on the ventricular side of the tricuspid valves the many thin fibres attached to the folds of the valves, the *chordæ tendinæ*, and their attachment at the other end to the *columnæ carneæ*, or muscular pillars.

Hold the right ventricle. Pour water into the *pulmonary artery* (lung). Raise the ventricular flap, and observe from below the form and mode of closing of the *semilunar valves*. Then continue the last incision, and lay open the *semilunar valve* and the *pulmonary artery*.

Lay open the *left auricle* in the same manner as the right. Study the mitral valve and use water as before. Note the thickness of the walls of the *pulmonary veins* and of the *auricles*. Lay open the *left ventricle* in the same manner as the right. Note the very thick walls and the great firmness of the tissues near the apex. Compare the walls of the auricles and ventricles as to the thickness and firmness. Observe the *mitral valve* from the ventricle. Notice its greater thickness and rigidity as compared with the tricuspid, also the increased size and strength of the chordæ tendinæ and the columnæ carnæ. Lay open the aorta. Examine its coats, their layers, thickness, and elasticity. Observe the entrance to the *coronary arteries* (the nutrient arteries of the heart-muscle) in the anterior sinuses.

QUESTIONS.

The Heart.

116. Where is the heart found? What is it? 117. How is the heart divided? What chambers? What openings? 118. Where are valves found? What do they permit?

The Blood-Tubes.

119. Describe the arteries. 120. Describe the veins. Where are they found? 121. Speak of cap'il-la-ries: position; size; walls. 122. Where are capillaries found? arteries? Why? Veins? 123. Write the circulatory system summary. 124. What keeps the blood in motion? By what conveyed? What may cause death of a part?

Structural Changes induced by Alcohol.

125. How does alcohol change heart-structure? 126. What defects in a fatty heart? What follows? 127. How does alcohol affect arteries? 128. What causes ap'o-plex-y? Who are liable? Why?

Work of the Lymphatics.

129. Describe the lym-phat'ics. Where do they end? 130. What are lymphatic glands? What has been noticed? 131. What do the lymphatics do? the glands?

CHAPTER X.

PHYSIOLOGY OF THE CIRCULATION.

HOW THE BLOOD IS MOVED.

132. Action of the Heart.—The heart is a hollow organ. When its muscles contract, the blood in the lower cavities of the heart (117) is forced out into the arteries and thence to all parts of the body. (Fig. 11.)

When the heart-walls expand, a fresh amount of blood enters the upper cavities of the heart from the veins; and the lower cavities from the upper (*a*).

133. Regular Action.—The heart-muscles contract and expand at regular intervals. These regular contractions keep the blood in constant motion in all parts of the living body.

134. Heart-Work.—At birth the heart contracts about 135 times each minute; at the tenth year about 90 times; and at the thirtieth year (adult) about 70 times.

135. Heart-Rest.—The heart works night and day. If it should stop working for a few minutes only we should die. The heart-muscle rests while

the cavities of the heart are expanding. (*Dem. III.*) The sum of these little rests is nearly nine hours daily.

IRREGULAR HEART-ACTION.

136. In Fainting the heart beats very slow, or, for a short time, ceases beating (*b*). Fainting is commonly due to the sending of impure blood to the heart and brain.

Bad air makes impure blood. Tobacco-using injures the blood. Too little good food makes poor blood.

137. Tobacco-Heart.—When the doctor says that Charlie B., or that Col. A., has a “tobacco-heart,” it means that the blood, the brain-cells, the heart-muscle, and the heart-nerves have been severely hurt by the tobacco used. It means that the heart works improperly and irregularly, causing distress and even pain under severe exertions.

138. Tea-Drinker’s Heart.—The use of tea causes the heart unnecessary extra work, as does alcohol (139). When tea is drank in excess it may cause a peculiar beating called *pal-pi-ta’tion*. This peculiar beating happens in “old tea-drinkers” when they are obliged to hurry.

139. Alcohol and Heart-Action.—When a temperate person takes a moderate dose of alcohol, the heart increases the number of its beats. Alcohol

thus causes the heart to work faster, to lessen its rests, and to wear out faster.

140. *A large dose of alcohol* slows the heart's action. It may stop the heart's action quite rapidly. Snake-poison slows the heart's action very powerfully. After snake-bite spirits should be used with care (c).

141. Chloral (klo'ral), when used for some time, may cause heart-trouble. It lessens the heart's power. It makes its action irregular. It sometimes, in a small dose, causes death by suddenly stopping the heart's action (96).

(a) FOR THE TEACHER. **Experiment I.**—Procure a Davidson's rubber bulb-syringe. Show the construction to the class: the *elastic bulb* in the course of the tubing, and the *valves*. Between the bulb and the pipe-section of the tubing is a valve opening towards the pipe. Between the suction-pipe and the bulb is a valve opening towards the bulb.

Action.—Holding the bulb in the hand place the suction-end and the pipe-end under water. Squeeze the bulb,—a few bubbles of air will escape. Relax the hand,—the elastic bulb expands. Squeeze the bulb again,—bubbles of air and a little water escape from the pipe. By repeating the squeezings and the relaxations, a stream of water soon will issue from the pipe with each squeeze.

The forward movement.—When the bulb containing water is squeezed, the water cannot go back into the basin because the valve in the suction-pipe stops the way. The water must go forward into the pipe, or the rubber bulb must crack open, or the suction-pipe-valve give way under the severe squeezing. When the water has left the bulb it cannot return to the bulb, because the valve in the pipe-tubing is closed against a back-current. Now when the hand is relaxed and the bulb again expands, water is sucked into (more properly, is forced into the bulb by the pressure of air on the water in the basin) the bulb, which again, by the squeezings of the hand, is forced out, and so on and on.

Comparison with the heart.—Request the pupils to open their books to Fig. 20 and to follow the demonstration. When the muscular walls of the ventricles (2, 10) contract the blood cannot return to the auricles because the *tri-cuspid* (17) and *mitral* (19) valves prevent, hence it must go forward into the arteries (3, 11), just as the water in the squeezed bulb was forced into the pipe-tube. When the heart ceases contraction and expands, this blood cannot come back into the ventricles because of the *sem'i-lu-nar* (18, 20) valves, just as the pipe-tube-valve prevents the water returning.

After the contraction the ventricles expand. A vacant space would now be formed, but the blood in the auricles (1, 9) which now contract, and in the large *venæ cavae* (15, 16) rushes in from the venous side and again fills the ventricles, as occurs through the suction-pipe into the expanding bulb.

In the living heart these contractions, valve-closures, and expansions occur regularly and frequently. The right and the left ventricles contract at the same time, expand together and rest together. The right and left auricles contract, expand, and rest together.

Experiment II.—Remove the lead-sinker from the suction-end of the suction-tube. Fill the bulb and tubes with water. Now push the pipe into the open end of the suction-tube.

If the bulb be now squeezed, the water in the bulb will be forced forward into the tube forming the circuit. The tube becomes over-full. The rubber-tubing swells out. (The arteries after each heart-beat also swell out because they are made of elastic tissue.) When the bulb is relaxed, a part of the water in the tube-circuit enters the bulb and the tubing contracts to its normal size. Thus we can force the water round and round.

All warm-blooded animals (man, dog, sheep, birds) have two hearts and a double circulation,—the circulations connecting in the capillaries of the lungs and the capillaries of the body at large.

FOR THE TEACHER. Demonstration I.—*The Pulse.*—Place the fore-finger lightly on the radial artery. This artery lies just over the radius and just under the skin, on the thumb side of the wrist, about half an inch from the edge. The skin over the artery is felt to rise and fall at regular intervals. The sensation conveyed to the finger is called the *pulse*. It informs us how many times the heart contracts, as in a minute of time; how strong it beats, and if it beats regularly.

Request all members of the class to place the fore-finger of one hand over the radial artery of the other. Let them count the beats for one minute. Place the results on the black-board and ascertain the average for the class. In high fever the pulse may indicate as many as 170 heart contractions per minute, and in the early stage of opium poisoning as low as 35 contractions per minute.

Demonstration II.—*Heart-Impulse.*—On the left side of the chest, commencing at the collar-bone (clavicle), count down to the fifth rib. Place the palm of the hand over the fifth space. An impulse will be felt at regular intervals. Place a finger of the other hand over the radial artery. The impulse nearly coincides with the pulse. This impulse, or shock, is due to the contracting heart striking against the walls of the chest.

Demonstration III.—*Heart-Sounds.*—Request a friend to remove all clothing from the chest, save the under-shirt. Find the heart-impulse-place. Place your ear against that spot. Put the finger of one hand on the radial pulse of your friend. Listen attentively and notice: (a) the impulse of the heart; (b) a dull sound like "lubb"; (c) a slight pause; (d) a sharp sound like "düpp"; (e) a longer pause (less than half a second). Listen to this again and again: "lubb," "düpp," pause; "lubb," "düpp," pause.

The "lubb" is mainly due to the closure of the valves between the auricles and ventricles; the "düpp" to the closure of the semi-lunar valves at the entrance of the aorta and of the artery to the lungs. The long and short pauses are the periods of rest for the heart-muscle.

(b) **Management of Fainting.**—Place the person flat on the back. If possible lower

the shoulders and head and elevate the limbs. This enables more blood to go to the brain. Loosen all the clothing. Cut all tight bands. Keep the people from crowding around. This secures more and better air. Dash cold water in the face. This latter excites deeper breathing.

(c) **Management of Snake-Bite.**—Tie a cord or band between the bite and the heart. (See Fig. 14.) Cut near the wound to favor bleeding. If your mouth is sound suck the wound; if not, apply a live coal to the bite. Later apply a poultice to the bite. Give ordinary alcohol (a tablespoonful), water of ammonia (five to ten drops), and quinia (one to three grains) in a little hot water. Repeat every ten minutes. Continue as long as the heart's action is benefited. As the condition improves, gradually increase the intervals of administration.

QUESTIONS.

How the Blood is moved.

132. What happens when the heart-muscle contracts? When the heart-muscle expands? **133.** What occurs regularly? What results? **134.** Speak of the work of the heart. **135.** When does the heart work? When can it rest? How much?

Irregular Heart-Action.

136. What takes place in fainting? To what due? What makes impure blood? **137.** What is injured in "tobacco-heart"? How shown? **138.** What may tea cause? What causes pal-pi-ta'-tion? When is it commonly excited? **139.** How does alcohol affect heart-action? What results? **140.** How does a large dose of alcohol affect heart-action? Snake-poison? Hence? **141.** What is the influence of chloral on the heart? What may happen?

CHAPTER XI.

PHYSIOLOGY AND HYGIENE OF THE CIRCULATION.

HOW THE BLOOD MOVES.

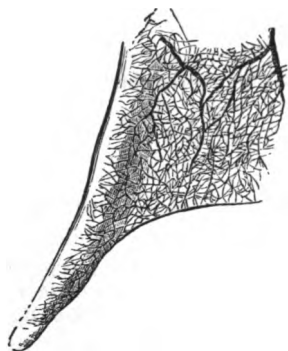


FIG. 18. *A piece of the web of a frog's foot showing the capillary net-work.*



FIG. 19. *The arrows show the course of the corpuscles in the web of a frog's foot. (Magnified thirty diameters.)*

142. Capillary Motion.—Many persons have seen the cor'pus-cles (kor'pus-ls), moving in the wing of the bat and in the web of the frog. (Fig. 18.) A few persons have seen the cor'pus-cles moving in the back part of the human eye. The blood moves from the arteries to the veins (a).

143. Direction of the Current.—Pressure on the arm (*Dem. b*), the flow in the web of the

frog's foot (Fig. 19), and the blood flowing from the surfaces of a wound show us that the *arteries* convey the blood *from* the heart, and the *veins* *towards* the heart.

144. Motion of the Blood.—In the *cap'il-laries* the flow is uniform; in the *ar'te-ries* in waves thus causing "the pulse" (*Dem. I. Chap. X.*), and in the *veins* in a steady stream (*b*).

THE COURSE OF THE BLOOD.

145. Blood-Flow.—The contractions of the *left heart* cause the blood to reach every part of the body by forcing it into the a-or'ta and its branches. (Fig. 11, *the white bands*.)

The con-trac'tions of the *right heart* cause the blood to reach all portions of the lungs by forcing it into the pul'mo-na-ry ar'te-ry and its branches. (Fig. 26, ^{8, 9}.)

HYGIENIC HINTS.

146. Wear loose garments and comfortable shoes.—Close-fitting garments, shoes, and gloves impede the movements of the blood. They cause the skin to become too cool and the inner organs too warm.

147. People who are not robust should always wear woollen under-clothing even in the summer.—Such clothing tends to equalize the work of the heart, for it keeps the skin warmer.

148. *In the summer and autumn always wear a broad woollen waist-band during the night.*—It will prevent most colics and sudden “morning di-ar-rhœ’as” (di-ar-re’ahs).

149. *Steady pressure on the skin makes it pale.*—This is due to the pressing of the blood out of the surface capillaries. Hence wear loose, elastic bands on the limbs.

150. *“Make haste slowly.”*—When in haste to reach a distant point, as a burning building, start out at a walk and increase the speed gradually to a quick walk, a trot, and, when heart and lungs work well, then full speed.

ACTION OF NARCOTICS AND STIMULANTS.

151. Narcotics.—Alcohol injures the heart-structure. Alcohol and chloral and tobacco cause the heart to work improperly. They act more intensely on the young and the growing than the robust, out-of-door working-man. Hence they ought not to be used by the young.

152. Stimulants.—Tea and coffee are stim’ulants. They do not give force or food to the heart. They cause the heart extra work. Hence they are not needed by the young and ought not to be used by them.

(a) FOR THE TEACHER. **Demonstration of the Blood-Movements.**—Wrap a live frog in a moist cloth, allowing one hind leg to stick out.

With tapes fasten a live frog on a piece of stiff card-board. Near the toes of one

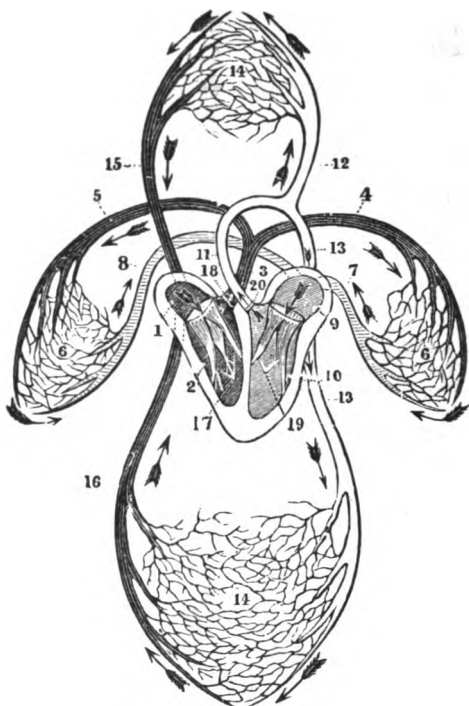


FIG. 20. *An ideal view of the circulation in the lungs and system (a).*

outstretched hind limb cut a hole in the card three-quarters of an inch in diameter. Attach threads to two adjacent toes. So arrange the threads that the stretched web comes over the centre of the hole. Place a drop of water on the web, and over the same a thin cover-glass. Use on the microscope a 1-inch or $\frac{3}{4}$ -inch objective. Observe the moving bodies; the *red* and the *white* corpuscles; the comparatively small number of the latter; the walls of the channels; the rapid central current; the slow wall-current; and the pigmented granules in the web. (Figs. 18, 19.)

(b) **Demonstration of the Course of the Blood-Current.**—Place a twisted handkerchief loosely about the arm, tie it securely and insert a small rod, as in Fig. 14. Place the finger over the radial artery. Twist the stick until the skin is compressed,—the veins under the skin of the fore-arm swell out. Loosen the twisting,—the veins grow smaller and the skin appears natural. Twist again,—the veins swell up, yet the radial pulse continues,—i.e., the blood flows *from* the heart in the arteries and *towards* the heart in the veins. Twist still more,—the radial pulse ceases, the veins

do not further enlarge and do not grow smaller, but the artery above the handkerchief beats strongly and the skin appears normal. If the twisting is kept up for some minutes, the hand will become cool, for no new and warmer blood arrives, and the parts also become painful.

(a) FOR THE TEACHER.—With the books open to Fig. 20 it is suggested that the teacher start the pupils from different points, as 1, 9, 14, etc., and request them to trace the course of the blood, naming the tubes, parts, and valves in turn around to the starting-point. Later, drill them in the same manner on Fig. 11; also on the anatomical chart of the circulatory organs.

The Lung Circulation.—From the *right ventricle* of the heart (Fig. 20, 2), the dark impure blood is forced into the pulmonary artery (3); and its branches (4, 5) carry the blood to the left and right lung. In the capillary vessels (6, 6) of the lungs, the blood becomes pure, or of a scarlet color, and is returned to the left auricle of the heart (9) by the veins (7, 8).

The General Circulation.—From the *left auricle* the pure blood passes into the left ventricle (10). By a forcible contraction of the left ventricle of the heart the blood is thrown into the aorta (11). Its branches (12, 13, 13) carry the pure blood to every organ, or part of the body. The divisions and subdivisions of the aorta terminate in capillary vessels, represented by 14, 14. In these hair-like vessels the blood becomes dark-colored, and is returned to the right auricle of the heart (1) by the *ve'na ca'va de-sen'dens* (15) and *ve'na ca'va as cen'dens* (16). (See Fig. 11.)

The Valve-Action.—The *tricuspid valves* (17) prevent the reflow of the blood from the right ventricle to the right auricle. The *semi-lunar valves* (18) prevent the blood passing from the pulmonary artery to the right ventricle. The *mitral valves* (19) prevent the flow of blood from the left ventricle to the left auricle. The *semi-lunar valves* (20) prevent the reflow of blood from the aorta to the left ventricle.

QUESTIONS.

How the Blood moves.

142. Where has blood-motion been seen? In what direction?
 143. How was the course of the blood-current proven? What is the direction?
 144. How does the blood flow in the cap'il-la-ries? arteries? veins?
 145. Where is the blood forced by the left heart? the right?

Hygienic Hints.

146. State objections to the use of close-fitting apparel.
 147. Why should woollen under-clothing be worn?
 148. What acts to prevent summer illness? Hence?
 149. Why are elastic bands to be preferred?
 150. How would you run, as to a fire?

Action of Narcotics and Stimulants.

151. What is the influence of alcohol? Of chloral? Who are most affected? Hence?
 152. What are not foods? What evil do they induce? Hence?

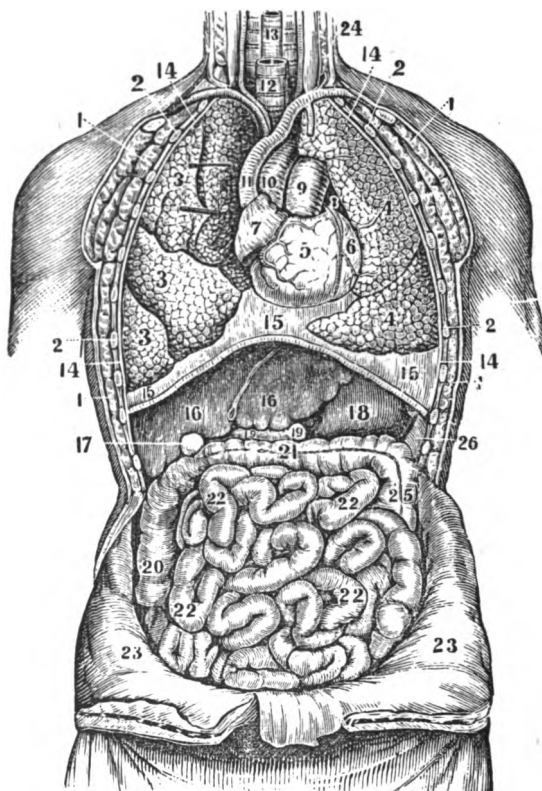


FIG. 21. A front view of the organs of the chest and abdomen.—1, 1, 1, 1, The muscles of the chest. 2, 2, 2, 2, The ribs. 3, 3, 3, The lobes of the right lung. 4, 4, The lobes of the left lung. 5, The right ventricle of the heart. 6, The left ventricle. 7, The right auricle. 8, The left auricle. 9, The pulmonary artery. 10, The aorta. 11, The vena cava descendens. 12, The trachea. 13, The œsophagus. 14, 14, 14, 14, The pleura. 15, 15, 15, The diaphragm. 16, 16, The lobes of the liver. 17, The gall-bladder. 18, The stomach. 19, 19, The duodenum. 20, 21, 25, The large intestine. 22, 22, 22, 22, The small intestine. 23, 23, The abdominal walls turned down. 24, The thoracic duct, opening into the left subclavian vein. 26, The spleen.

CHAPTER XII.

THE BREATHING APPARATUS.

153. The Need of Air.—I have met a sailor who lived *four days* without food or water. In Yezo I took care of a boy of fourteen who lay in the snow, ice, and water of a swamp, because of frozen feet, twenty-eight days in March and April, 1880. For *twenty-five days* he had no food. I have never read of a man who has lived as much as *five minutes* without air.

154. The Air contains a vital food. It is called *oxygen* (ox'i-jen). It forms about one-fifth of a good air.

THE AIR-PASSAGES.

155. The Air-Passages are the

Two nostrils.

Two nasal passages (Fig. 22).

Phar'ynx (fār'inks), or throat (Fig. 22).

Lar'ynx (lār'inks), or Adam's apple (Fig. 22).

Tra'che-a (trā-kee-ah), or wind-pipe (Fig. 22).

Bron'chi-al tubes (brōn'kee-al), (Fig. 24,^{5, 6}).

Air-cells (sells) Fig. 24,^{9, 9}).

156. Mucous Membrane.—The air-passages are lined by a thin, inner skin,—the *mucous membrane*. It is red in color. It secretes a moisture called *mu'cus* (*a*).

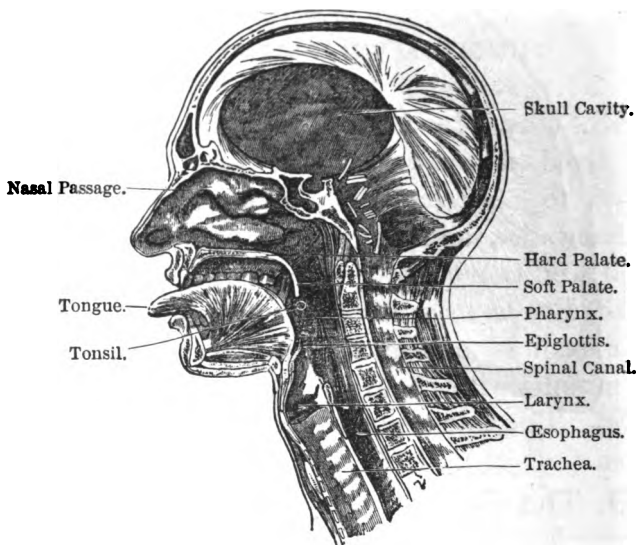


FIG. 22. Section of head and neck in the median line.

157. Open Passages.—The air-passages are always open. Hence the air, in health, can pass freely in and out (*b*).

THE CHEST AND ITS CONTENTS.

158. The Chest (or Tho'rax) is a bony cage-work (Fig. 21) filled in with muscles. It holds and

protects the heart, lungs, great blood-tubes, and the gullet.

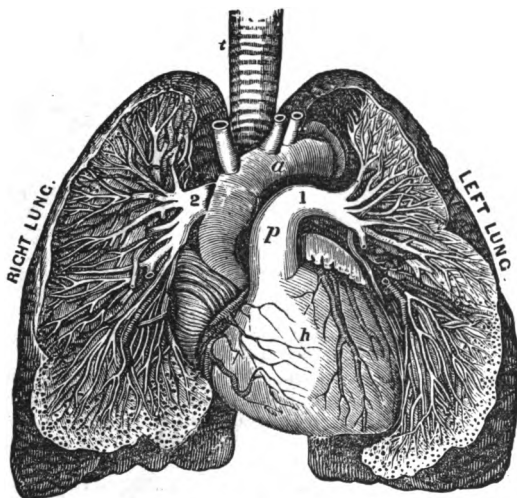


FIG. 23 The heart, lungs, and trachea.—*t*, Trachea; *a*, Arch of aorta; *h*, Heart 1, 2, Pulmonary artery.

159. The Diaphragm (di'a-fram) is a broad, thin muscle. It separates the thorax from the abdomen. (Fig. 32.) It is the great breathing-muscle.

160. The Lungs are two in number. The right is the larger. (Fig. 21.) The lung is soft, elastic, and light.

161. Lung-Structure.—The trachea (Fig. 24, ⁴) is like the trunk of a tree; the bronchial tubes (Fig. 24, ^{5, 6}) like its limbs, branches, and twigs, and the air-cells like the leaves. (Fig. 24, ⁹.)

162. The Air-Cells are surrounded by a fine

net-work of capillary blood-tubes. (Fig. 25,⁵.) The air in the air-cells and the blood in the cap'il-la-ry

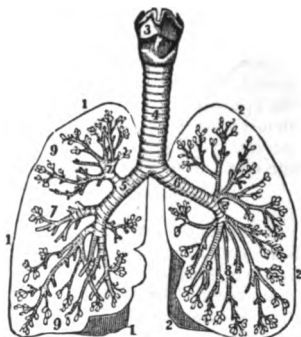


FIG. 24. *Diagram of the lower air-passages.*—1, Outline of right lung. 2, Outline of left lung. 3, Larynx. 4, Trachea. 5, 6, 7, 8, Bronchial tubes. 9, 9, Air-cells.



FIG. 25. (*Leidy.*) *Diagram of two lobules of the lungs, magnified.*—1, Bronchial tube. 2, A pair of primary lobules connected by fibro-elastic tissue. 3, Air-passages. 4, Air-cells. 5, Branches of the pulmonary artery and vein.

tubes are separated by two very, very thin membranes only.

(a) FOR THE TEACHER. *Directions for Dissection.*—Open the thorax as directed in Chapter IX. (Fig. 16).

When the thorax of a dog or rat is opened, air enters the pleural cavities; the lungs, which had hitherto filled the large right and left chambers of the thorax, shrink somewhat. Before removing the thoracic viscera, bend two straws of broom-corn into a sickle shape, pass one into each nostril, and then urge them gently forward to their whole length. Open the mouth, gently move the soft curtain attached to the back part of the roof of the mouth to one side, and the two straws will be seen projecting into a cavity or open sac, the *pharynx*. The passages in which the straws lie are separated from each other by a long and cartilaginous septum, and from the mouth by bone and a soft fleshy curtain.

Remove the larynx, trachea, lungs, and heart, as directed in Chapter IX. At the upper or anterior part we encounter the *larynx*, an irregular cartilaginous box, opening above into a membranous sac, the *pharynx*, and below into a cartilaginous tube, the *trachea*. Observe on the upper front of the larynx a stiff, elastic, projecting, tongue-like mass, the *epiglottis*. Press this down, and it is seen to close over a slit-like opening in the larynx.

Lay open the LARYNX by an incision on the œsophageal side. In the interior, from above downward, note: the *mucus* on the surface, the two continuous surfaces

forming the upper *slit*, two right and left pits, the *ventricles of the larynx*, and two thin, contiguous surfaces, forming the *vocal cords*, and the cut *cricoid*, with the two *arytenoid* cartilages resting thereon.

The *trachea* is found to be an open tube. The trachea divides into two partly cartilaginous tubes, the *bronchi*, which in turn, as a rule, divide and subdivide by twos. The cartilages in these latter soon disappear, they only being represented by membrane. The lumen of these tubes grows smaller and smaller, and is lost to sight in the soft, elastic, pinkish mass called the *lung*.

Entering the *lung-mass*, side by side with the bronchi, are seen the open, firm *arterial* tubes, and the numerous dark, thin, flattened *veins*. These bronchi, arteries, and veins, together with the accompanying nerves, lymphatics, and connective tissue, constitute the *root of the lung*. The smooth outer surface of the lung-mass is the *pulmonary pleura*. By a dainty scratch a portion of a thin membrane, the *pleura*, may be raised into view.

Squeeze a portion of fresh lung-mass, and there arises a sensation called *crepitation*; throw a bit into water, and it is seen to float; hold a bit under water, squeeze it, and bubbles will be seen to arise,—the *residual air* of the lung.

(b) The frame-work of the nostrils keeps them open. The nasal passages and the throat are channels between bones; the *lar'ynx* and trachea have rings or plates of cartilage in their walls, and the bronchi-al tubes have bits of cartilage in their walls.

QUESTIONS.

Air.

153. How long may a person live without food? Without air?
154. What does air contain? What amount?

The Air-Passages.

155. Name, in order, the divisions of the air-passages. 156.
What is the mucous (mu'kus) membrane? What is mucus?
157. What are open? Hence?

The Thorax and its Contents.

158. What is the thorax? What does it contain? 159. Describe the diaphragm (di'a-gram). What does it do? 160. Speak of the lungs. 161. Compare the air-passages with a tree. 162. What surrounds the air-cells? Hence?

CHAPTER XIII.

THE PHYSIOLOGY OF BREATHING.

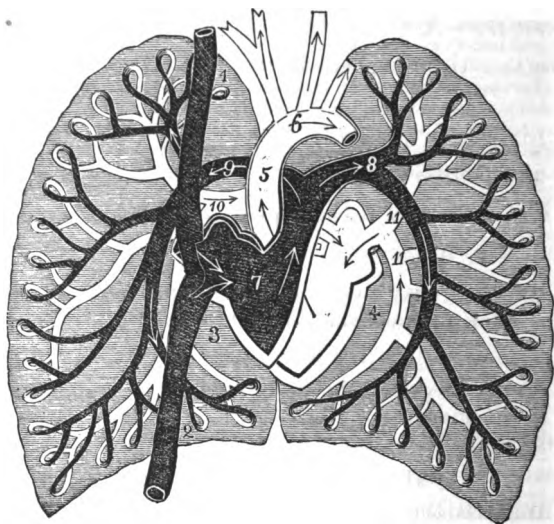


FIG. 26. *A diagram of the pulmonary circulation.*—1, Vein bringing blood from the head, etc. 2, Vein bringing blood from lower parts of the body. 3, 4, Lung in section. 5, Aorta. 6, Arch of aorta. 7, Right heart. 8, 9, Pulmonary arteries. 10, 11, Pulmonary veins. The arrows show the direction of the blood-stream.

HOW WE BREATHE.

163. Breathing is the taking in and giving out of air. In a healthy adult it occurs about seventeen times each minute (*a*).

164. Inspiration.—When the diaphragm (di'a-
fram) contracts (Fig. 27), and when the muscles be-
tween the ribs (Fig. 21,^{1,1})
contract, the cavity of the
chest is made larger. (Fig.
27,^{4,5}.) An empty space is
made in the chest.

Results.—Air rushes in
through the air-passages
(155). The lungs expand.
New air reaches the air-cells.
This is *in-spi-ra'tion*.

165. Expiration.—
When the muscles between
the ribs and the di'a-phragm
cease contracting, the capac-
ity of the chest becomes less.
(Fig. 27,^{1,3,7}.)

Results.—A part of the
air in the air-passages of
the lungs is forced out. This
is *ex-pi-ra'tion*.

**166. The Outward
Passage.**—The bad air,
leaving the air-cells, enters
the bronchial (bron'kee-al) tubes, from which it
passes into the many-ringed trachea (tray'kee-ah),
and thence through the larynx (lar'inks), pharynx

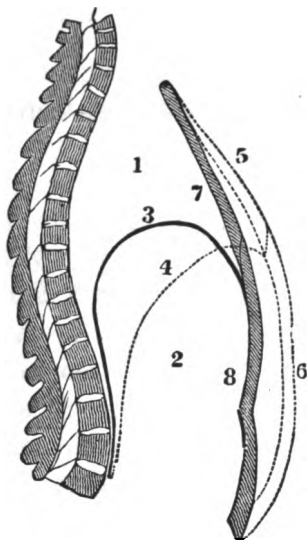


FIG. 27. A section-view of the chest and abdomen in respiration.—1, The cavity of the chest. 2, The cavity of the abdomen. 3, The line of direction for the diaphragm when relaxed in expiration. 4, The line of direction for the diaphragm when contracted in inspiration. 5, 6, The position of the front walls of the chest and abdomen in inspiration. 7, 8, The position of the front walls of the abdomen and chest in expiration.

(far'inks), and nasal passages to the outer air. (Figs. 24, 22.)

CHANGES EFFECTED BY BREATHING.

167. Effects of Breathing.—(1) The *fresh air*, which enters with every breath, takes in a new supply of oxygen. (2) The air which passes out in *expi-ra'tion* takes away a part of the wastes and much water. It also takes away about one-fifth of the heat made in the body (383).

168. Impure Blood.—The blood which comes from the right heart to the lungs is impure blood. It is of a dark red color. The impure blood is laden with wastes, especially *car-bon'ic acid gas*. The wastes have been sucked up in all parts of the body.

169. Changes occurring in the Lungs.—*Wastes* (especially *car-bon'ic acid*) pass from the dark blood through the blood-tube walls and the air-cell walls to the air-cell. A *food* (*ox'y-gen*) passes from the air-cell through the air-cell walls and the blood-tube walls to the blood. (Fig. 26.)

170. Results.—*Car-bon'ic acid* and bad-smelling compounds are cast from the blood. Later, they are passed out of the body by way of the air-passages (166).

Oxygen is taken in and the red corpuscles become bright red. The corpuscles convey it to all parts.

171. Summary.—

<i>Inspiration.</i> .	{	Thorax enlarges.
		New air rushes in.
		Oxygen (a food) is introduced.
<i>Interchanges.</i>	{	Fresh oxygen enters the blood.
		Wastes are cast from the blood.
<i>Expiration.</i> .	{	Thorax lessens in size.
		Heat is lost.
		Wastes are expelled.

(a) FOR THE TEACHER. **Directions for Demonstrations.**—Let a healthy boy remove the apparel covering his neck and chest, except a close-fitting undershirt. Have him stand easily erect and execute four or six full respirations in a deliberate manner, the class, meanwhile, watching the movements attentively.

Place a tape snugly around the chest, about three inches below the armpits. Notice the difference in circumference during a full inspiration and a complete expiration,—1st, in normal breathing; 2d, in labored breathing. Notice that the right half-circle of the chest is usually larger. If a spirometer can be procured, test the air-capacity of the lungs.

Place the forefinger flat on the wall of the chest. Tap this finger smartly with the first two fingers of the other hand. Test different parts of the chest in front and in the rear in the same manner. A clear sound denotes the presence of air in the organs beneath; a dull sound, the presence of solids or liquids. The healthy lung-areas give forth a clear sound. By this method, the limits of the lungs, the heart, the liver, and the intestines may be approximately mapped out.

Place the ear on the skin over the region of the trachea in front; a blowing sound is heard both in inspiration and in expiration. Then place the ear on the shirt, over the lung-areas, pressing the latter smoothly and closely on the chest-walls. Listen in one place during several respirations. Shift the ear to different parts of the chest, and listen. A soft, low, murmuring sound is heard, being most marked over the front and upper parts of the chest and during inspiration. The murmur is mainly caused by the air passing in and out of the air-sacs and air-cells.

Experiments.—Take a clean glass (fruit) jar with cover; fasten a piece of candle, with wire or a small nail, near the end of a stick twenty inches long. Lower the lighted candle into the jar: it will burn freely. Reverse the jar; shake after the taper is withdrawn. Now have some person take a full inspiration, retaining the air, for a time, in the lungs; then steadily expel it from the lungs into the jar, directing the current to one side; cover; soon breathe again in the same manner into the glass vessel, and lower a lighted candle. The flame will be extinguished, because the carbonic acid, the watery vapor, and other gases from the lungs have so vitiated the air in the jar as to prevent combustion.

Place a little fresh lime-water in a jar; breathe several times into it; cover,

and shake the lime-water. Instead of a clear liquid, there will be formed the white carbonate of lime.

Put a live rat in a jar. Regulate the supply of air by the cover, giving a liberal supply, a limited supply, and then total exclusion of air, and notice the results.

Breathe on the cool surface of a clean mirror, and *watery vapor* will be condensed from the saturated exhaled air. Take a clean, cool mirror into the recitation-room. In a few minutes examine the moist surface.

If onions or leeks have been recently eaten, ether or chloroform inhaled, or alcoholics recently drunk, or if persons have decayed teeth, the expired air will give forth odors easily detected. The air from a crowded room, or badly ventilated room, is tainted with odors from the air-passages, the throat, the mouth, the nasal passages, the skin, and unclean clothing. These are made known to us by the sense of smell. *These are the dangerous factors in a once breathed air.*

Borrow the doctor's clinical thermometer. Test the temperature of the expired air. Compare the readings with the room-air readings.

QUESTIONS.

How we Breathe.

163. What is breathing? How often? 164. What muscles act in in-spi-ra'tion? State the changes; the results. 165. What causes ex-pi-ra'tion? What follows? 166. Through what channels does the out-going air pass?

Changes effected by Breathing.

167. What is taken in? What is cast out? What is lost? 168. What is peculiar about the blood from the right heart? What does it contain? Where gathered? 169. How are wastes cast out? How is ox'y-gen taken in? 170. What is passed out? How expelled? What change occurs? What becomes of the oxygen? 171. Write the summary of the breathing process.

CHAPTER XIV.

HYGIENE OF BREATHING.

HOW TO BREATHE.

172. *Breathe a pure air.* A good air is clear and cool. It has no dusts, no odor, and no taste. It is free from smoke.

173. *Breathe through the nostrils.* When the entering air passes through the *air-passages* (Fig. 30, ^{7, 26, 27}) it is warmed and moistened. Hence, when it reaches the lungs, the air is agreeable.

Observation.—The American Indians are remarkably free from diseases of the nose, throat, and ears. This freedom is largely due to their habit of breathing through the nostrils.

174. *Avoid breathing through the mouth.* Breathing through the mouth, as when a person *snore*s, makes the mouth and throat dry and bad smelling. Mouth-breathing is a frequent cause of sore-throat, colds, coughs, and even lung-fever.

THE NERVES OF SMELL.

175. *The Nerves of Smell* are found in the upper nasal passages. (Fig. 28, ⁵.) When we breathe a good air they are not excited. Odors excite them.

176. Uses.—These special nerves are placed at the entrance of the air-passages to warn us against bad airs. Hence, when the air smells bad, we should leave the room or place at once.

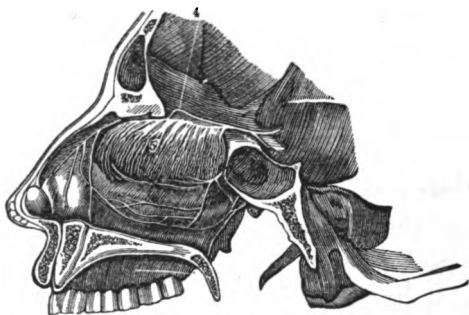


FIG. 28. A side-view of the passage of the nostrils and the distribution of the nerve of smell.—4, The olfactory bulb. 5, The fine divisions of this nerve in the membrane of the nose.

177. Tobacco-smoke blunts the sense of smell. It injures the texture of the membrane lining the nose and throat. *Snuff-taking* is even more injurious to this sense than smoking.

INJURIOUS ACTIONS OF ALCOHOL, OPIUM, AND TOBACCO.

178. Alcohol and the Blood.—When an alcoholic is drunk, its alcohol soon reaches the blood. It rapidly mixes with the plasma. In a few moments some of it has visited every part of the body.

179. Alcohol in excess hurts the feeding power of the plasma. It acts to hinder the passing out of the

wastes of the body. It also hinders the taking in of oxygen.

180. Alcohol and Lung-Disease.—It is not true that alcohol is a “cure for con-sump’tion.” It is very doubtful if alcohol acts to prevent consumption.

181. Alcoholic Breath.—When alcohol is taken in excess then a part of it may be cast out (as alcohol) by the lungs (395).

182. Opium-Smoking.—The Chinese method of taking opium by “smoking” does less harm to the body and mind than does the American method of taking it by the stomach, or under the skin.

183. Tobacco-Smoke.—The hot smoke injures the linings of the mouth, throat, and larynx. The hot smoke and the drugs of the tobacco cause redness, dryness, irritation, coughing, and even disease of the linings of the air-passages.

184. Cigarette-smoking is the most injurious form of smoking: (1) The entering smoke is hotter. (2) The drugs of the tobacco more largely and more quickly enter the blood. It is the tobacco and not the paper that injures the young cigarette-smoker.

HYGIENIC HINTS.

185. Personal.—*Practise deep breathing daily.* It is an excellent method to guard against consumption. Always breathe through the nose.

186. *When possible sleep in an upper room. Dampness and ma-la'ri-a act most injuriously near the ground.*

Be sure that the sleeping-room window is lowered (from the top) every night, so that the bad air can quickly pass out. Let the night air in freely, and let it out freely.

187. *Do not wear close-fitting chest and waist garments. Corsets and tight vests compress the lower ribs. (Fig. 29.) They press the digestive organs out of place. They hinder deep and proper breathing.*

188. *Avoid an air laden with smoke and dusts, as coal-, pottery-, and steel-dusts. Dusts cause lung-disease.*

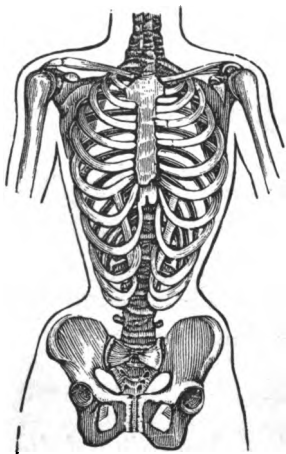


FIG. 29. *A deformed chest.*

189. *When the lamps burn dim, open the windows. A lamp will not burn well in a bad air. A bad smell is a sign of danger.*

190. *Stand erect. Sit erect. Keep the shoulders well back. This will give you a fine appearance. This will enable you to breathe better. This will make you healthier (15).*

191. *Household.—The sunlight should freely*

enter each living-, working-, or sleeping-room. Sun-light makes the air pure and healthy.

192. *The open fire is the healthiest method of warming a small room.*

There should be no damper in the stove-pipe. It hinders the passing away of the bad gases from the fire.

193. Ventilation.—In the cold weather, keep a board about five inches wide under the lower sash of each window. This allows fresh air to constantly enter where the lower sash overlaps the upper sash. Always have one sash lowered from the top, thus allowing foul air to pass out. *Foul air is the great inducer of consumption.*

194. *Allow no refuse or filth to gather in, under, or near the home.* In decaying they taint the air. Filth feeds the germs of disease (a). It is best to burn refuse which cannot be at once used in the soil.

(a) **Epidemics.**—When cholera, yellow fever, typhoid fever, scarlet fever, diphtheria, and other infectious diseases prevail, be clean. Keep your skin clean. See to it that the cellar, the sink-waste, the eaves, the ditches, and the grounds about the house are free from leaves, refuse, and filth. Wash, air, and sun the clothing and the bedding. All these efforts are directed to make the air clean and pure and to prevent the germs of disease living and increasing near the home. Live on simple, plain, wholesome food. Ripe fruits are safe. Wash the hands and mouth before eating. If the water is suspicious, only drink boiled water, which has been cooled by putting ice about the pitcher. Boil the milk, if you are not certain of its source. AVOID ALCOHOLICS. They increase the tendency to most diseases.

QUESTIONS.

How to Breathe.

- 172.** What is peculiar to a pure air? **173.** Why breathe through the nostrils? What has been noticed? How accounted for?
174. State objections to mouth-breathing.

The Nerves of Smell.

175. Where are the nerves of smell located? How excited?
176. Why are they so placed? Hence? **177.** What is the influence of tobacco-smoke? of snuff?

Injurious Actions of Alcohol, Opium, and Tobacco.

178. What becomes of an alcoholic? Where is it taken? **179.** What is the action of an excess on the plasma? on wastes? on ox'y-gen-taking? **180.** Speak of alcohol and con-sump'tion. **181.** What may become of an excess of alcohol? **182.** Speak of the methods of opium-taking. **183.** What is injured by tobacco-smoke? What often results? **184.** Why is cigarette-smoking so hurtful? To what due?

Hygienic Hints.

185. Why practise deep breathing? **186.** Why sleep in an upper room? What should be done nightly? **187.** Mention objections to close-fitting waist- or chest-garments. **188.** What should be avoided? Why? **189.** Mention signs of danger. **190.** Why is the erect posture desirable? **191.** What does sunlight do? Hence? **192.** How best warm a room? What should not be used? Why? **193.** How can you ventilate an ordinary room? What danger from using foul air? **194.** What shall be done with filth? Why? What is best?

CHAPTER XV.

VOICE.

THE VOCAL ORGANS.

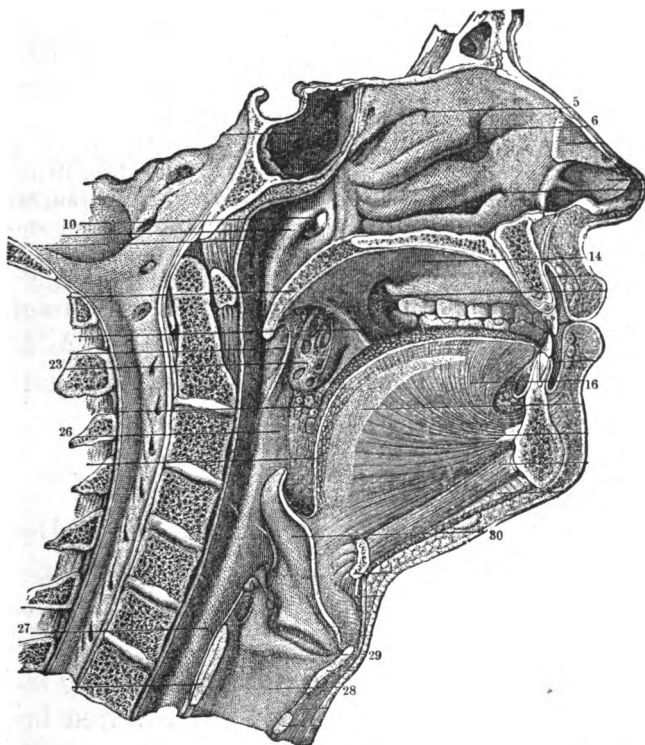


FIG. 30. *Vertical section of face and neck.*—5, 6, 7, Outer wall of left nose. 10, Entrance to tube leading to middle ear. 14, Roof of mouth. 16, Tongue. 23, Tonsil. 26, 27, Pharynx. 28, Larynx. 29, Left vocal cord (upper line). 30, Epiglottis.

f

195. The Larynx (lar'inks) is made up of carti-la-ges. (Fig. 30,²⁸) It forms the "Adam's apple."

196. The Vocal Cords are two in number. They are within the larynx. (Fig. 30,²⁹)

197. The Epiglottis is the lid of the larynx. It acts to keep food or drink from entering the larynx. (Fig. 30,³⁰)

HOW WE MAKE SOUNDS.

198. The Larynx is the organ of voice. In breathing the air passes in and out freely, producing no sound.

199. Vocal Sound.—By the action of the minute muscles inside the larynx the cords are brought near together. When air is then forced from the lungs through the larynx the cords vibrate and a *vocal sound* (*a, e, i, o, u*) results (*a*).

HYGIENIC HINTS.

200. Practice tends to improve the voice. Deep breathing improves the cultured voice. Singing causes the voice to improve in clearness, in firmness, and in strength.

201. We learn to speak, as well as to sing, by imitating the sounds which we hear. If children hear good words and gentle tones, they will use good words and polite tones.

202. *Children should be encouraged to speak and sing in a natural tone.* They should utter the con' so-nant sounds as well as the vowel sounds clearly and distinctly.

203. *The posture during vocal exercises should be erect, yet easy.* The garments of the neck, chest, and waist ought to be loose fitting (187).

204. *Strong tobacco is known to injure the vocal organs.* Young singers should not use tobacco or alcoholics. The latter sometimes injure the voice; neither improve the voice.

(a) FOR THE TEACHER. *Illustration.*—In a toy-trumpet the blast of air blown through it causes the brass reeds to vibrate and sound is produced. In the larynx, the blast of air forced from the lungs causes the vocal cords to vibrate and to produce a vocal or vowel sound.

Sounds.—*Vowel* sounds are produced in the larynx. *Con'so-nant* sounds are produced in the air-passages above the vocal cords. These sounds are varied by the position of tongue, teeth, lips, and cheeks.

Demonstration.—Let the teacher pronounce the consonant sounds, while the pupils note the changes in the position of the parts of the face and neck. Also utter the vowels.

QUESTIONS.

The Vocal Organs.

195. What of the larynx (lar'inks)? **196.** Speak of the vocal cords. **197.** What is the ep-i-glot'tis? What does it do?

How we make Sounds.

198. What is the larynx? What is noticed in breathing? **199.** What is done in the larynx? What causes the cords to vibrate? What results?

Hygienic Hints.

200. What improves the voice? What advantage from singing? **201.** How do we learn to speak? Hence? **202.** How should children speak? What should be uttered clearly? **203.** Speak of posture and clothing. **204.** What injures the vocal organs? the voice? Hence?

CHAPTER XVI.

WATER AND OTHER FOODS.

WATER.

205. Water.—Nearly seven-tenths of the living body is water. A person needs about five pints daily.

206. A Good Water is clear and bright. It has no odor or taste. It is the best of bever-ages.

207. Drinking-Water.—Country rain-water, when filtered, is healthy. Ice-water is "heavy." Spring-water is the safest and the best (*a*).

208. Shallow-Well-Waters are dangerous.—When the well is near the house or barn, then too often the sink-waste, the privy-waste, and the barn-waste leak into the well. (Fig. 31.) Such wastes in the drinking-water cause ill-health (fevers, di-arrhœas) (*b*).

209. The Germs of chol'e-ra, ty-phoid- (*ti'foïd*) and yellow-fevers are carried from the sick to the healthy. These germs most often pass into the system in the drinking-water taken from shallow wells or stagnant pools (*c*).

210. Prevention of Disease.—Drink pure

water. It is safest to cool the water by placing ice about the jar, not in it. When diseases like ty'phoid fever are common, drink water that has been boiled.

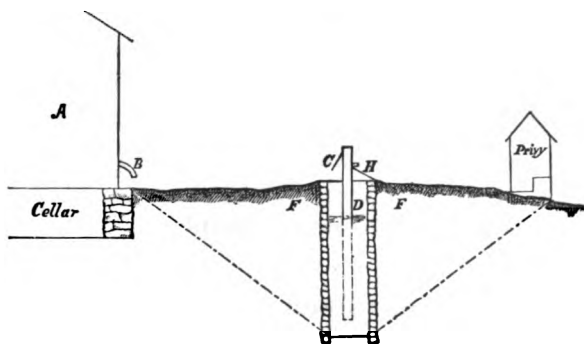


FIG. 31. *Well-drainage cone*.—A, house; B, sink-spout; C, pump, thirty feet from the house; D, well twenty feet deep; F, cone of soil; H, sloping pump-trough.

211. The Well.—It should be at least fifty feet away from the pig-sty, the sink waste-pool, or other filthy spot. Surface-washings should not be allowed to run into the well. The ground around the well should be grassed.

212. Lead-Poisoning sometimes occurs from using shallow-well- or rain-waters which have slowly passed through lead-pipes. Lead causes “wrist-drop” and colicky pains.

FOODS.

213. Foods.—*Water* is a food. The *ox'y-gen* from the air is a food. The *starches* of flour, meal,

and seeds are food. The *oils* found in grains and meats are foods. The *ni'tro-gen com'pounds* of lean meat, the white of an egg, etc., are foods. *Salt* is a food.

214. Milk is a perfect food. It has bone-making and flesh-making matters. It contains matters to repair the wasting blood and wasting organs. It is rich in heat-making and strength-giving matters.

ANIMAL FOODS.

215. Cow's Milk is best when taken fresh. It should be sipped or taken in small swallows. Hot milk is most excellent for tired persons. *Cheese* is a rich and hearty food suitable for hard workers.

216. Eggs form a rich food. Raw eggs are easily digested. "Hard-boiled" and fried eggs are difficult to digest.

217. Meats are rich in fats and *ni'tro-gen com'pounds*. Beef and venison are best. Pork is good, though difficult to digest.

218. Selection of Meats.—Good meat has a good odor. It is uniform to the touch. Bad meat has soft spots.

219. Dangers in Meats.—Pork and ham sometimes contain a worm called *tri-chi'na* (*tri-ki'na*). This worm causes in man a painful and even fatal disease. Man derives the *tape-worm* most commonly from hog-flesh.

220. *Eat no raw meat.* Eat no uncooked smoked meats. Eat only well-cooked flesh.

221. Fresh Fish is an excellent food. As a rule it is lacking in fats. *Stale fish* soon develops poison properties, and is dangerous.

VEGETABLE FOODS.

222. White Wheat-Bread is lacking in bone-making matters; also in fats and ni'tro-gen compounds. Hence meats, fish, butter, and eggs should be largely used with white bread.

223. Yeast-Bread is the most wholesome bread. Stale bread is healthier than fresh bread, for it is more easy to digest; for the same reason the crust is better than the interior.

224. Children's Foods.—Children should not be fed on white wheat-bread. They need bone-making (5), muscle-making, and teeth-making food. Hence they should live almost entirely on cracked-wheat, oatmeal, milk, and fruits (33).

225. Potato and Rice are very poor in bone-making materials. *Indian-corn, beans, and peas* are good foods for hard-working persons, like soldiers, lumbermen, laborers.

226. Vegetables have little value as foods. They are good to supply bulk or to give flavor to other foods.

227. Fruits are valuable for their flavors and

their juices. They have very little feeding power. Avoid unripe fruits.

228. Tinned-Foods.—Avoid all tinned-foods which have a bad odor or taste. Never keep the food in the opened tin.

229. Mineral-Foods.—With the exception of *common salt*, a common good diet contains all the bone-making elements needed. Salt, in moderation, is needed in most foods.

COOKING.

230. Fire.—Man uses fire to make his food more agreeable to the taste and more easy to digest.

231. Method of Cooking.—*Roasting* and *broiling* are the best methods of cooking flesh, as well as most vegetables. “Baked potato” is far better than “boiled potato.” *Boiling* is a ready means of cooking, hence it is most often employed.

232. Frying is the most objectionable method of cooking. It causes heated fat to enter the food-mass. Heated fat is slow and difficult to digest.

233. Pastry and Cake.—They contain large amounts of butter or lard which has been highly heated. They are less easy to digest than bread. Small amounts of plain cake do little or no harm.

(a) Wholesome.	{	1. Spring-water.	}	Very palatable.
		2. Deep-well-water.		
		3. Grass-land surface-water.		
Suspicious.	{	4. Stored rain-water.	}	Moderately palatable.
		5. Surface-water from cultivated land.		
Dangerous.	{	6. River-water, with sewage-access.	}	
		7. Shallow-well-water.		

(Frankland.)

(b) **A Shallow Well** is one whose depth is rarely more than twenty-five feet. The water which enters such a well comes from the soil near the well. Such water enters the well too quickly to be cleaned by the soil and sand. (Fig. 31.)

(c) In June, 1886, a young man came to his home in Waterford, Wis., sick with ty'phoid fever. The utensils used in his case were rinsed under the family pump. On July 5, with the thermometer at 108° in the shade, all the pupils of the neighboring school drank of the infected water. In a few days nearly every pupil was severely ill with ty'phoid fever! The epidemic involved the people of the town also!

QUESTIONS.

Water.

205. How much water in the body? How much is needed?
206. Describe a good water. 207. Mention good drinking-waters.
208. When is well-water unsafe? Why? 209. What diseases are carried by germs? How are some germs conveyed? 210. What should be done to avoid some diseases? 211. Where should the well be placed? What should be done near the well?
212. What leads to lead-poisoning? What is caused?

Foods.

213. What supplies ox'y-gen? starches? oils? ni'tro-gen compounds? 214. Why is milk a perfect food?

215. How should milk be taken? What is excellent? Speak of cheese. 216. Tell about eggs as food. 217. Why are meats valuable? Mention some meats. 218. Compare a good with a bad meat. 219. What may contain the trichina (tri-ki'na)? What results? Speak of tape-worm. 220. What should not be eaten?
221. What is lacking in fish? Why is stale fish objectionable?

Vegetable Foods.

222. What is lacking in white bread? Hence? 223. What is wholesome? Why use stale bread? 224. Why should children not use white bread constantly? What is good for them? 225. Speak of potato; corn; beans. 226. For what are vegetables valuable? 227. What do fruits supply? What avoid?

228. What care is necessary with tinned-foods? 229. How is salt provided? What is needed?

Cooking.

230. Why does man use fire? 231. Speak of roasting; broiling; boiling. 232. Why is frying objectionable? 233. What is used in cake? What results?

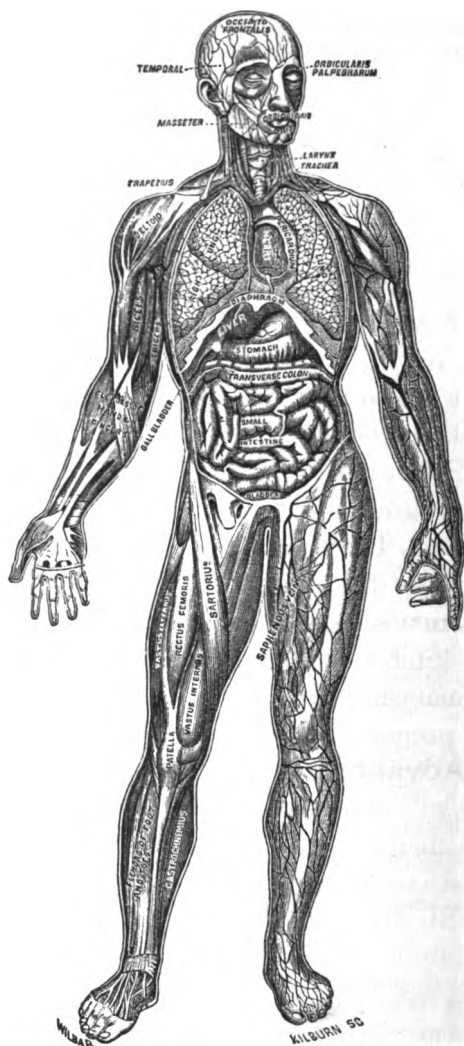


FIG. 32.

CHAPTER XVII.

THE DIGESTIVE APPARATUS.

WHY WE NEED TO DIGEST FOODS.

234. Raw Foods.—A man can sustain life on raw fruits, raw roots, raw flesh, milk, eggs, and water. It is better not to live in a savage state. It is better to use cooked foods.

235. Preparation of Food-Stuffs.—The *ox*, eating grass, and hay and grains, builds up the rich, juicy meat. The *miller*, using stones, rolls, and sieves, crushes the grains, removes the rough portions, and furnishes fine flours and meals.

In the kitchen, the *cook* combines many raw and prepared materials, uses heat (as in baking and boiling), and prepares tempting and tasty dishes.

236. Advantages of Preparation.—The work of the *ox*, of the *miller*, and of the *cook* so changes raw foods that we can easily gain strength from prepared foods. Well-prepared foods lessen the work of the teeth, stomach, and bowels.

237. Need of Digestion.—Most foods (water, salt, and a part of milk excepted) must be changed in the body before they are fit to enter the living blood.

THE MOUTH PARTS.

238. The Mouth is an irregular cavity in the face. (Fig. 30.) It contains the *teeth* and the *tongue* (a). It is lined with *mu'cous mem'brane* (156).

239. The Teeth, in children under seven, may number twenty; in healthy adults, thirty-two. They are placed in sockets in the upper and lower jaws. (Fig. 30.)

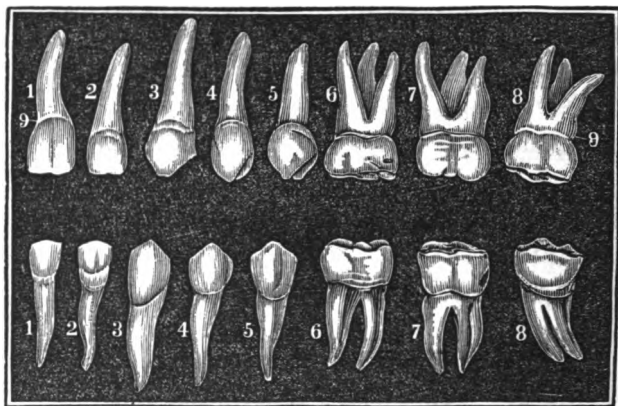


FIG. 33. *Teeth of an adult*.—1, 2, Incisors. 3, Canines (cus'pids). 4, 5, Pre-molars (bi-cus'pids). 6, 7, 8, Molars (grind'ers). 9, 9, Neck of tooth.

240. Uses of the Teeth.—(1) The sharp *cutting teeth* (in-ci'sors) divide the food; the *dog-teeth* (ca-nine') enable us to hold food, and the broad *mo'lar teeth* grind and crush the food. (Fig. 33.) (2) The teeth enable us to speak clearly and distinctly. (3) They add beauty to the face.

241. The Tongue is made up of many muscles. It can move in many directions. (Fig. 30,¹⁶)

242. Functions.—The tongue aids in speaking, in keeping the food between the teeth during chewing, and in pushing food back into the throat.

INJURIOUS ACTIONS OF TOBACCO.

243. Tobacco-chewing fouls the mouth and taints the breath. Tobacco sometimes hastens the decay of the enamel. It may soften the gums.

244. Tobacco-smoking exposes the mouth and throat to sudden changes, as from hot to cold. These rapid changes produce redness, heat, and swelling in the mouth and throat. Smoking sometimes causes a disease called "smoker's sore throat."

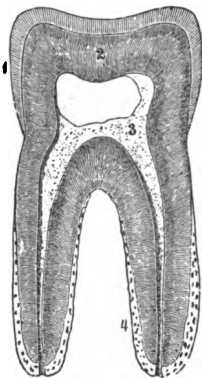


FIG. 34. Vertical section of a molar tooth.—A tooth is mainly made up of bony matter, 2. In the middle is the pulp-cavity, 3, which holds the nerve and blood-tube. The outer surface and the edges are covered by enamel, 1, which is harder than bone.

THE NERVES OF TASTE.

245. The Nerves of the Sense of Taste are mostly seated in the tongue. (Fig. 35,^{1,2}) The endings are most numerous near the tip.

246. Uses.—The great use of taste is to warn

us against improper foods, hence its nerves are placed where food is taken in.

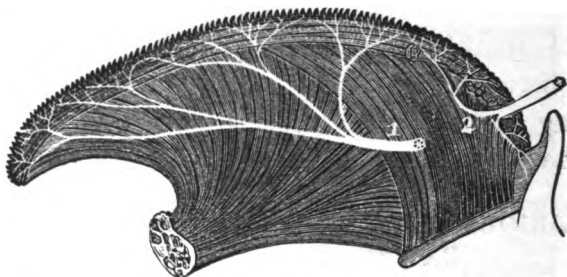


FIG. 35. A section of the tongue.—1, 2, Nerves of taste ending in the papillæ.

247. *Taste is injured by over-use.* It is dulled by the use of improper foods. Hence it may be educated to pass objectionable foods, as rotting fish or “gamey” flesh.

HYGIENE.

248. *All desire a sweet-smelling mouth.* As tobacco fouls the mouth, it ought not to be used. Food remaining in the mouth soon decays and hastens tooth-decay. *The mouth should be rinsed with tepid water after each meal.* Particles of food between the teeth are best removed by quill or ivory tooth-picks.

249. *The teeth should be carefully brushed, front and rear, morning and night.* A fine soap, followed by free rinsing, may be used from time to time. Beware of cheap, acid tooth-powders.

(a) FOR THE TEACHER. Directions for Examination of the Mouth Parts.
—Request a boy having a good set of teeth to stand before the class. Call attention

to the *lips* and the *dental arch*. Insertion of teeth, the gums, order of teeth from the median line,—*incisors*, *canines*, *bicuspside*, and *molars*; variations in the cutting surfaces; of the grinding surfaces; points of decay.

Movements of the lower jaw: forward, backward, to the right or left, and combinations of movements. Place the finger in front of the ear, over the jaw articulations, then move the jaw slightly, then stretch open; notice the degree of motion. *Hard palate*: notice its hard surfaces, with ridges, the soft posterior portion terminating in the soft palate, or *uvula*. *Tongue*: its free apex, its bridle, its veins prominent on the lower surface. On its upper surface note the numerous *papillæ*. Observe the variety of movements which the tongue can execute.

Throat: Request the boy to stand in the sunlight, mouth wide open, head slightly thrown back, and then to articulate slowly, Ah—ah—h—h. Thus the *soft palate* will be elevated, and the throat parts brought into view: the *soft palate* in the middle line, the right and left almond-shaped *tonsils*, then the posterior wall of the *pharynx* in the central field.

Observe that the mouth and pharynx are lined with *mucous membrane*, and that the surfaces are bathed with mucus. If the mouth is suddenly opened, a jet of fluid may come from near the second upper molar tooth,—saliva from the *duct of Steno* (parotid), or, if the tongue is raised, from the floor,—saliva from *Wharton's ducts*.

QUESTIONS.

Why we need to Digest Foods.

234. Upon what can a man live? What is better? 235. What is done by the ox? the miller? the cook? 236. What advantages follow from the careful preparing of foods? 237. Why must we digest foods?

The Mouth Parts.

238. What is the mouth? What is in it? 239. How many teeth? Where placed? 240. What is the first use for teeth? the second? the third? 241. Speak of the tongue. 242. What are the duties of the tongue?

Injurious Actions of Tobacco.

243. Mention some actions of tobacco. 244. What does tobacco-smoking induce? What changes follow?

The Nerves of Taste.

245. What are seated in the tongue? 246. What is the great use of taste? 247. How may taste be injured? What is over-come?

Hygiene.

248. What fouls the mouth? What causes decay? What should be done? 249. How should the teeth be cared for? What is to be shunned?

CHAPTER XVIII.

THE DIGESTIVE APPARATUS—Continued.

THE DIGESTIVE CANAL.

250. The Mouth is the upper opening of the di-ges'tive canal. The ducts which convey the sa-li'va end in it. (Fig. 30.)

251. The Pharynx (far'inks), or *throat*, is a passage seated back of and below the mouth. (Fig. 30, ^{26, 27}.) The air uses this passage to reach the larynx (lar'inks), and the food to reach the gullet.

252. The Œsophagus (e-söf'a-güs), or *gullet*, is a mus'cu-lar tube leading from the throat to the stomach. (Fig. 22.)

253. The Stomach (stüm'ak) is seated under the left side of the diaphragm (di'a-fram). It is a pear-shaped bag. (Fig. 36.) Its walls contain muscular fibres. (Fig. 36, ^b.)

254. The Bowels, or *in-tes'tines*, lead from the stomach. The *small intestine* (Fig. 32) is about twenty feet long. The *large intestine* (Fig. 21, ^{20, 21, 25}) is about six feet long. They lie coiled in the ab-do'men.

255. The Abdomen (belly) is the cavity of the

body between the diaphragm and the pel'vis. It is lined by the thin *per-i-to-ne'um*. Its walls are mainly muscular. (Fig. 21, ^{23, 23.})

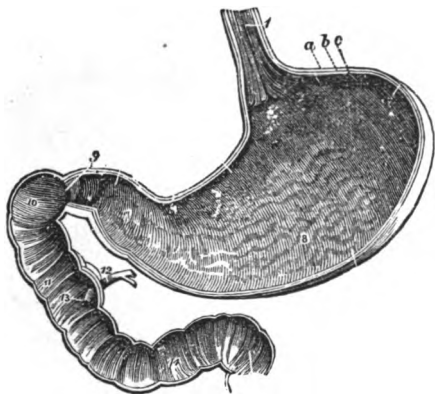


FIG. 36. *The inner surface of the stomach and duodenum.*—1, The lower portion of the esophagus. 8, Stomach. 9, The pylorus through which the food passes out of the stomach into the duodenum, or upper portion of the small intestine. 10, 11, 14, The duodenum. 12, 13, Ducts through which bile and pancreatic fluid pass into it. a, b, c, The three coats of the stomach.

256. Contents.—The abdomen shelters the stomach, bow'els, liv'er, pan'cre-as, kid'neys, and blood-tubes.

THE DIGESTIVE GLANDS.

257. A Gland is a soft solid made up of se-cret'-ing-cells, of blood-tubes, and of ducts held together by meshes of fine fibres.

258. Gland-Work.—The gland-cells make from the blood *juices*, or se-cre'tions. The *ducts* convey away the secretions.

259. The Saliva (spit'tle) is a frothy fluid. It appears abundantly in the mouth during the chewing process. It is made by the *sal'i-va-ry glands*, which number three pair. (Fig. 37,^{1,3,5})



FIG. 37. A view of the salivary glands in their proper situations.—1, The parotid gland. 2, Its duct. 3, The submaxillary gland. 4, Its duct. 5, The sublingual gland, brought to view by the removal of a section of the lower jaw.

260. The Liver is the largest gland in the body. It is dark red in color. It is found on the right side of the ab-do'men. (Fig. 32.) The liver secretes the *bile*. It forms *glycogen* (gl'ik'o-jen) from the food. It aids in casting out *ni'tro-gen-wastes*.

261. The Gall-Bladder is placed on the under side of the liver. (Fig. 21,¹⁷). Its duct leads to the small intestine. It stores the yellow, bitter *bile*.

262. The Pancreas (pan'kre-as) is a long gland

found near the stomach. It forms the *pan-cre-at'ic juice*. Its duct leads to the small intestine.

263. Mucous Glands.—In the lining of the *mouth* mucus is found. In the walls of the *stomach* glands secrete an acid juice. In the walls of the *small intestine* glands secrete in-tes'ti-nal juices. *All these secretions, in their proper order, are needed in digestion.*

264. Summary of the Digestive Organs.—

<i>In the Head</i> .	{ Mouth.	{ Teeth.
		{ Tongue.
		{ Mucous Glands.
	{ Salivary Glands.	
<i>In the Neck</i> .	Throat.	
<i>In the Chest</i> .	Gullet.	
<i>In the Abdo- men</i> . . .	{	Stomach (Stomach-Glands).
		Small Intestine (Intestinal Glands).
		Large Intestine.
		Liver—Pancreas.

CHANGES IN STRUCTURE INDUCED BY ALCOHOL.

265. In the Stomach.—As a result of the use of strong al'co-hol-ics, in excess, for a long time, the walls of the stomach often become thickened and leathery. The stomach often becomes lined with a thick, ropy, foul mucus.

266. Stomach to Liver.—Water and alcoholics taken by the mouth reach the blood through walls of

the stomach and small intestine. This blood flows at once to the liver. Hence the evil actions of alcohol are severely felt in the liver.

267. In the Liver.—Alcohol is one of the most common causes of disease of the liver. When used in excess for long times, it causes changes in the structure of the liver. These are fatty (in the main) or hardening changes.

268. In the Glands.—Alcohol, after a time, produces changes in the structure of most glands. These changes more or less unfit the glands for their proper work.

(a) FOR THE TEACHER. **Directions for Dissection.**—Secure the animal (dog, rabbit, or rat) and open thorax and abdomen as directed in Chapter IX. Observe the pale *abdominal muscles*; the glistening *fascia* of the muscles; the fibres of the *external oblique* muscle.

Remove the skin from one side of the face and neck. Near the lower jaw and in front of and below the ear the lobulated, pale brown *salivary glands* can be readily dissected out.

With scissors, divide in the median line the walls. A large cavity, lined by a smooth moist membrane, the *peritoneum*, is exposed. This membrane lines the abdominal cavity. (Fig. 16.) Without cutting or tearing, but by simply turning over or pulling aside, trace the *alimentary canal* from near the left inferior side of the diaphragm, viz., the narrow *oesophagus*, the dilated *stomach*, the convoluted small *intestine*, the large, dark, sacculated *cæcum*, with its worm-like *appendix*, the large *intestine*, containing balls of excrement, and the *rectum*. Trace out the *mesentery*, made of two folds of the peritoneum, enclosing blood-vessels, lymphatics, and nerves, which connects the alimentary canal to the vertebral region. If the dog is in good condition, a loose, mesenteric, fatty apron, the *great omentum*, will be seen hanging from the lower border of the stomach.

Notice the dark-purple-colored long body lying near the broad end of the stomach, the *spleen*. Observe the form, the lobes, the tubes entering, and the attachments of the large, dark-red solid organ, the *liver*. Now turn over the stomach, slightly stretch the small intestine, and notice within the mesentery the long, hammer-like, pale-red, lobated *pancreas*. Trace the *duct* from the pancreas to its entrance into the small intestine, about a foot from the stomach.

Turn the stomach and intestines to the right side (towards the liver side of the animal). Notice the *abdominal aorta* at its exit from the diaphragm. Follow its branches to the principal organs. Turn the stomach and intestines to the left side.

Trace the flaccid tubes (containing dark maroon blood) from the mesentery, spleen, and stomach until they unite in a single trunk, the *portal vein*, which is seen to enter the liver. Observe the *vena cava ascendens* as it enters the diaphragm, receiving blood from the liver. Turn the dark-red liver up towards the diaphragm, and its greenish *gall-bladder*, with its *cystic duct*, and the *hepatic duct* (from the liver), forming one *common duct*, will be brought into view.

Tie strings about the upper and lower parts of the canal. Remove the alimentary canal and its appendages by cutting the mesentery free from the posterior walls of the abdomen, then carefully trim the mesentery from the alimentary canal. Examine the tube externally from the stomach to the rectum.

Remove the glands. Cut open the *liver*. Note its dark-red, firm, uniform structure. Cut open the *spleen*. Note its fibrous investment, its pulpy contents, and the absence of a duct. Separate the long, pale-red *pancreas*, and note its friable, lobulated character. Observe to the right and left of the backbone a compact, roundish bean-shaped solid organ, invested by fat, the *kidney*. Notice the *ureter*, a pale, firm-feeling duct, running from a depression in the kidney towards the middle line into the *pelvis*, and ending in the *bladder*.

QUESTIONS.

The Digestive Canal.

250. What is the mouth? What end in it? 251. Where is the pharynx (far'inks) found? For what used? 252. What is the oesophagus (e-sof'a-gus)? 253. Where is the stomach (stüm'ak) found? Describe it. 254. Speak of the bowels; of the small and large in-tes'tines. 255. What is the ab-dō'men? How lined? How made? 256. What is held in the abdomen?

The Digestive Glands.

257. What is a gland? 258. What is the work of gland-cells? of the ducts? 259. Describe the sa-li'va. By what made? 260. Speak of the liver. Where found? What is its work? 261. Where is the gall-bladder found? Where does its duct end? What does it do?

262. Speak of the pan'cre-as; its juice; its duct. 263. What is formed in the mouth? the stomach? the intestines? What is needed? 264. Write out the summary of the di-ges'tive organs.

Structural Changes induced by Alcohol.

265. What changes occur in the stomach from the use of strong al-co-hol'ics? What is sometimes seen? 266. How do fluids get into the blood? Where are they floated? Hence? 267. What is a cause of liver-disease? What changes does alcohol induce? 268. What does alcohol cause in glands? What must follow?

CHAPTER XIX.

DIGESTION.

269. Digestion (di-jes'tshun) includes all the changes which foods undergo in the mouth, the stomach (stüm'ak), and the bowels. Digestion makes *proper* foods fit to enter the blood (237).

270. Changes in the Mouth.—When we take some food, as beef and potato, into the mouth, the *tongue* acts to keep the food between the teeth. Under the motions of the lower jaw the *teeth* divide and crush the food. The *sa-li'va*, trickling into the mouth, wets the food and acts to change starchy foods (potato, cracker, white bread, etc.) into sugar (*a*).

271. Swallowing.—When a moist mass is formed, the *tongue* pushes it into the phar'ynx (far'inks). (Fig. 30, ^{26, 27}.) The *muscles of the throat* crowd it over the ep-i-glot'tis and into the gullet. The *muscles of the gullet* rapidly urge it on to the stomach (*b*).

272. Changes in the Stomach.—The muscles of the walls of the stomach churn the food back and forth. The mass becomes well mixed with the juices made by the glands of the stomach. A soft

pulpy mass is formed. The ni'tro-gen foods (beef, pork, white of eggs, etc.) are now changed into a digested form.

273. Absorption is the process by which digested foods and liquids pass from the digestive canal into the blood-tubes.

274. Stomach Absorption.—A portion of the starches and meats, having been digested, are sucked into the blood in the blood-tubes of the stomach. From time to time portions of the soft mass remaining are squeezed into the small intestine. (Fig. 36,¹⁰.)

275. *Ice-water, when taken with food, or soon after eating, hinders digestion.* (1) It makes the stomach cold and checks the making of juices. (2) It slows the digestive changes of meat, eggs, etc. Hence ice-water, or ice-cream, ought not to be freely taken with food, or soon after eating.

276. Changes in the Intestines.—All kinds of foods (bread, meats, fish, and oily foods) are largely digested in the small intestine. The *pan-cre-at'ic juice* (262) digests fats as well as all other food-materials.

277. *It is best not to drink while eating.* (1) Large amounts of fluid in the stomach slow stomach-digestion. (2) A large amount may wash foods too rapidly from the stomach to the intestine. (3) A large amount of fluid in the intestine very much

hinders intestinal digestion. Water, or other warm fluids, may be taken freely two to three hours after eating.

278. Intestinal Absorption.—The greater part of digested foods soak into the blood from the small intestine. The *waste parts* are sucked quite dry in the large intestine, and later are cast out of the bowels.

279. Summary of Digestion.—

<i>In the Mouth</i> . .	{	Chewing of food.
		Moistening of food.
		Starches change to sugar.
<i>In the Stomach</i> .	{	Churning and mixing of food.
		Flesh-foods digested.
		Digested-foods absorbed.
<i>In Small Intestine.</i>	{	Fats digested.
		All kinds of foods digested.
		Digested-foods absorbed.
<i>In Large Intestine.</i>		Watery fluids absorbed.

CHANGES IN THE BLOOD.

280. New Material.—We now have learned how new material reaches the blood: the ox'y-gen is taken in through the lungs, and the water and the common foods (after digestion) by soaking through the walls of the stomach and intestine. The new materials rapidly become uniformly mixed with the blood.

281. Changes in the New Material.—The

blood takes the new foods through the liver and other glands and the lungs. In these organs the new material is so changed that it becomes blood. How it is done we do not yet know.

(a) **Experiment.**—Wipe the mouth and tongue. Hold a bit of cracker. Remove. Move the mouth parts a few minutes, and then insert a new bit of cracker and hold a few moments. What changes have taken place in each case?

(b) **Observation.**—Watch a horse when he is drinking, or an ox when swallowing the cud. Notice the progress of the swallow of water or the mass of food; also the successive constrictive motions of the gullet.

QUESTIONS.

Digestion.

269. What is digestion (di-jes'tshun)? **What does it do?** **270.** What is done by the tongue? the lower jaw? the teeth? the *sa-li'va*? **271.** In swallowing, what is done by the muscles of the tongue? of the throat? of the gullet? **272.** What churns the food? What is added? What are digested?

273. Define *ab-sorp'tion*. **274.** What is absorbed from the stomach (*stüm'ak*)? What becomes of the *un-di-gest'ed* portion? **275.** Why should ice-water not be freely taken with food? Hence? **276.** What are digested in the small *in-tes'tine*? What can the *pan-cre-at'ic* juice do? **277.** Why should fluids not be taken with the food? When is it better to take them? **278.** What is absorbed from the small intestine? What becomes of the waste portions? **279.** Write out a summary of digestion.

Changes in the Blood.

280. How are new materials taken into the blood? What becomes of them? **281.** Where are the new materials changed? How are they changed?

CHAPTER XX.

HYGIENE OF THE DIGESTIVE APPARATUS.

ACTIONS OF INJURIOUS AGENTS.

282. Alcohol.—Beer, even in small amounts, hinders stomach-digestion. *Strong alcoholics*, if used continuously, spoil the appetite for proper foods. If taken in large doses continuously they almost ruin stomach-digestion.

283. Opium.—In moderate doses, as in “soothing syrups,” it lessens the desire for foods. It acts to slow digestion. It acts to clog the entire system (336).

284. Tobacco, when first used by children, often causes sickness at the stomach and even vomiting, for the child’s system rebels against the drug. As tobacco is not a food, children should not learn to use it.

285. Coffee in large doses hinders digestion. In moderate amounts it rarely injures adults. It is, however, not needed by child or youth (339).

286. Tea, even “weak tea,” is powerful in hindering and injuring digestion (*a*). When used as

“tea-drinkers” use it, it works quite as much harm to the digestive function as alcoholic drinks (340).

287. Pepper, Mustard, and Spices spur the digestive glands (109). The glands of a healthy child, or young person, do not need spurring. In adults, the too free use of ap’pe-tiz-ers often produces catarrh (ka’tar) of the stomach.

288. Confectionery.—Common pure candies contain, not only cane-sugar, but materials which are difficult to digest. Cheap candies are often dangerous and very hurtful compounds, because of their poisonous colors or flavors. *Candies*, when freely used, injure the teeth and derange the stomach (*b*). They educate a craving for articles not needed as food. They should be denied to children.

HYGIENIC HINTS.

289. Amount of Food.—Appetite is a safe guide when a person is in health, when the food is simple in kind, and when its preparation is plain.

290. Quality of Food.—*Simple foods*, plainly yet thoroughly cooked, favor digestion and health. Ripe fruits are wholesome.

A food which disagrees with a person ought to be avoided. As a rule, pastry, cheese, fresh white-bread, and “made dishes” most often cause discomfort.

Highly-spiced foods, mustard, sauces, and confectionery, should be excluded from the food of children

and youth. Their use often cultivates a craving for narcotics. "Hunger is the best sauce."

291. Manner of Eating.—*Eat slowly.* Carefully chew the food. Mix it thoroughly with the juices of the mouth. By so doing, you render digestion easy and rapid (270a).

292. *Tea should not be taken with starchy foods* (white-bread, cake, rice, etc.). It hinders digestion (286). It causes "acid-stomach." It causes the formation of gas in the stomach and bowels.

293. *Food should be taken only at regular intervals,*—as two to four times daily. The digestive organs need regular rests, as well as the working muscles of the body.

294. Manner of Drinking.—When thirsty, take a little water into the mouth, hold it a few moments, then slowly swallow. This is better than to gulp down a large amount (277). Water and milk are the beverages most suitable for children and youth.

295. *Rest the body and the mind before eating.* A rest, or a nap, after eating will favor digestion and health. All animals, when it is possible, sleep after having taken food.

296. *Pure air and active exercise are the best spurs for a languid digestion.* Do not use "bitters," tonics, or other alcoholics. They are deceptive and dangerous. *Beer or wine serve no good purpose in the healthy, growing body.*

(a) **Tea.**—The powerful slowing of salivary and pancreatic digestion by tea is due mainly to the *tannin* present. Tea is rich in tannin. Tannin is very soluble. You can no more have tea without tannin, than wine without alcohol. Tannin remarkably hinders the digestion of all starchy foods.

(b) **Management of a Poison Case.**—*Treat the person at once. Cause him to vomit by giving a tumbler of warm water with a teaspoonful of mustard in it. Send for the doctor.*

Antidotes.—ALWAYS CAUSE VOMITING. *If the poison is ACID, give chalk and water; powdered plastering and water; or soap and water, and plenty of warm water. If the poison is an ALKALI (like ammonia or potash), give vinegar and water or lemon-juice. If it is an IRRITANT POISON (like verdigris, corrosive sublimate, etc.), give rapidly beaten-up raw eggs. If it is an OPIUM COMPOUND, give strong coffee and keep the patient awake. If it is a VEGETABLE NARCOTIC (henbane, belladonna), keep him quiet. Always summon the ablest doctor to manage the case.*

QUESTIONS.

Actions of Injurious Agents.

282. How does beer affect digestion? Strong alcoholics? **283.** What is the action of opium? **284.** How does tobacco affect the young? Hence? **285.** Speak of the action of large doses of coffee; of moderate amounts. Is it needed? **286.** What is the action of tea? What may result? **287.** Mention some ap'petizers. Why not needed by children? What may they cause? **288.** State objections to the use of candies. What harm may they do?

Hygienic Hints.

289. When is appetite a safe guide? **290.** What favors digestion? discomfort? What should children avoid? Why? **291.** How should you eat? Why? **292.** With what should tea not be taken? Why? **293.** Why eat at regular hours? **294.** How should you drink? What are the best beverages? **295.** What is the influence of rest? **296.** Mention the better digestive spurs. What are to be avoided? Why?

CHAPTER XXI.

ANATOMY OF THE NERVOUS SYSTEM.

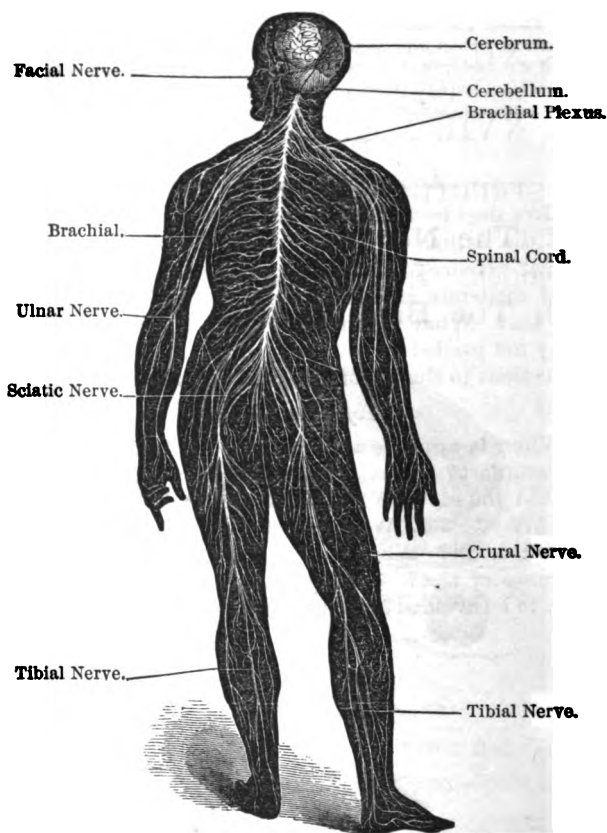


FIG. 38. *Diagram of brain, spinal cord, and spinal nerves.*

THE NERVOUS SYSTEM.

297. Our Studies have informed us about the frame-work, its coverings, and its work (Chaps. II.–VI.); about the blood and its movements (Chaps. VIII.–XI.); about the air-passages and breathing (Chaps. XII.–XV.); about water and food (Chap. XVI.); and about the digestive organs and digestion (Chaps. XVII.–XX.).

THE STRUCTURE OF THE NERVOUS SYSTEM.

298. The Nervous System will now engage our attention. It is the master system of the body.

299. The Brain is the large, grayish pulpy

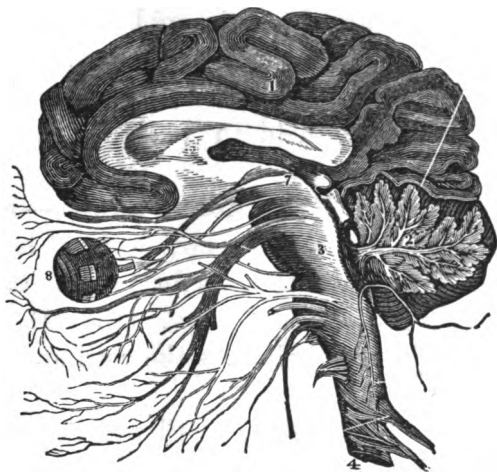


FIG. 39. *The right half of the brain and the nerves of the right side.*—1. Cerebrum. 2, Cerebellum. 3, Medulla. 4, Spinal Cord (upper end).

organ seated in the skull (a). It is made up of a right part and a left part. (Fig. 39.)

300. The Spinal Cord is a tail-like projection (not unlike a Chinaman's cue) of nerve-matter extending from the brain. (Fig. 38.)



FIG. 40. A section of the skull and spinal column. —1, 2, 3, The brain. 4, The spinal cord lying in the spinal canal.

301. Membranes.—The brain and spinal cord have three protecting membranes about them.

302. The Skull-Bones (see table of bones) form a closed cavity for the brain and its membranes. (Fig. 22, c.)

303. The Backbone is made up of a series of bones called *ver'te-bræ*. They are placed one on top of the other. (Fig. 40.) The bones are held in place by many lig'a-ments.

304. Spinal Canal.—Each vertebra has a large central hole. The series of holes form a long tube called the *spinal canal*. (Fig. 40, ⁴₄.) This canal shelters the cord and its membranes.

305. The Nerves are small white cords. (Fig. 38.) Those on the right side are similar to those on the left side of the body.

306. Some of the *nerves* extend from the *brain* through holes in the skull to the face, neck, and chest. (Fig. 39.) Other nerves extend from the *spinal cord* through holes in the spinal canal to all parts of the arms, chest, waist, and limbs. (Fig. 38.)

307. Ganglia.—In the chest and abdomen, in, or on, most organs, we find little nerve-masses. They are called *gan'gli-a*.

308. Nerve-Connections.—As the head office of a telegraph company is connected by wires with every office on its line, so the brain has nerve-fibres connecting it with every nerve-mass in each part of the body. Hence each part can send messages to the brain or receive messages from the brain.

309. Structure.—The brain, spinal cord, and gan'glia contain masses of minute *gray nerve-cells*. (Fig. 41.) The cells connect with each other by fine *white nerves*. (Fig. 41, ^{3, 5.}) *Nerves* are made up of many fine, white nerve-fibres.

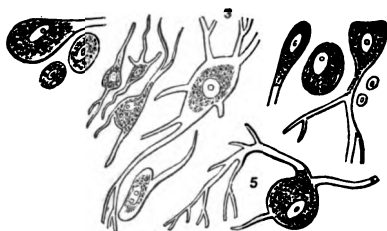


FIG. 41. *Isolated nerve-cells* (100 diameters).

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310. Summary.—

The <i>Nervous System</i> is made up of the	{	Brain. Spinal Cord. Gan'gli-a. Nerves (a) Brain-Nerves. (b) Spinal Nerves. (c) Gan'gli-on-ic Nerves.
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311. Alcohol, when used for long periods, produces changes in the structure of the brain, the ganglia, and the nerves. These changes are revealed by the mīcro-scope. They are of a hardening or of a fatty nature (267).

(a) FOR THE TEACHER. **Dissection of Head.**—Procure the head of a calf, a beef, or a pig. Remove the skin. In the middle line of the head saw vertically downwards through the skull and face, dividing the head into equal right and left parts. Remove splinters, loose tissue, clots, etc.

Note: The *connective tissue* which holds the scalp to the bones; the *periosteum*; the *outer plate of the skull-bones*; the *cavities* or the spongy bony tissue; the *inner plate* of the bones; the white firm fold of membrane (*falx*) dipping down between the right and left parts of the brain, and the firm membrane (*dura mater*) between the skull-bones and the brain.

Observe: The soft pulpy mass (*brain*) lying in the skull-case; the triangular-shaped, larger mass (*cerebrum*) showing irregular gray folds; the white band of nerve-matter (*corpus callosum*) which united it with the opposite half; the round mass (*cerebellum*) behind the cerebrum showing a tree-like arrangement of white in gray and the commencement of the *spinal cord*.

Commencing at the cord end, raise the cord out of its groove, cutting the *nerves* as they appear: raise out the cerebellum (using the scalpel-handle and the fingers); nick the *falx* and raise out the cerebrum, cutting the nerves as they appear. Place the half-brain in a shallow dish of water having a little alcohol.

Note the outer irregular folds in reddish gray (*convolutions*) of the cerebrum; the *ridges* of the cerebellum; and the abundant *blood-tubes*. Also note that the cerebrum, cerebellum, and spinal cord are connected by a mass of nerve-matter, the *pons*.

Turn the portion over. Observe at the base of the cerebrum, pons, and cord the stubs of the cut *cranial nerves*. The *olfactory bulb* (smell) is near the base of the nose. In the ox it is hollow. The round, prominent *optic nerves* (sight) lie just behind. With a thin, sharp knife shave off one-half of an inch of the inner surface of half of the brain. This brings into view the *gray outer layer* which dips down into the substance of the cerebrum; the *white central mass*; a cavity under the corpus callo-

sum (*ventricle*) and masses of gray matter (*basal ganglia*); also a clearer view of the *arbor-vitæ* ("tree of life") of the cerebellum.

Make a cross-section of the *spinal cord*. It is divided by a front-and-rear groove into a right and left part. The outer surface is white; the inner and connecting part is gray.

Examine the *skull*. Note the white, tough, lining membrane (*dura mater*); the fold of membrane (*tentorium*) separating the cerebral from the cerebellar cavities; the fold of membrane (*falx*) separating the upper parts of the right and left portions of the brain; the irregular *pits* in the inner surface of the skull-bones; the *openings* for the passage of the *twelve pairs of cranial nerves*, and the *passage* from the skull to the spinal canal.

Visit a butcher's shop. Examine the cut backbone of half of a beef. Note: the cut bone (*vertebræ*); the groove (*spinal canal*); the *spinal cord*, and the diverging *spinal nerves* passing outwards through openings between the *vertebræ*. Examine the cut surface of a thigh and note that the large *nerves* are found between the muscles and near the blood-tubes; that they are well sheltered, and that nerve-fibres radiate out to the adjacent muscles and other parts.

QUESTIONS.

The Nervous System.

297. What have we already learned? **298.** What is the nervous system? **299.** Describe the brain. **300.** What is the spinal cord? **301.** What protects the brain and cord? **302.** How many bones in the skull? What do they form? **303.** How is the backbone made up? How kept in shape? **304.** How is the spinal canal formed? What is its use? **305.** What are nerves? **306.** To what parts do the brain-nerves extend? the spinal nerves?

307. Where are ganglia found? **308.** What is noticed in a telegraph system? in the animal system? Hence? **309.** What elements are found in the nervous system? How connected? How are nerves made? **310.** Write a summary of the nervous system. **311.** What are changed by alcohol? How detected? What are the changes?

CHAPTER XXII.

PHYSIOLOGY OF THE NERVOUS SYSTEM.

DUTIES OF THE NERVOUS SYSTEM.

312. The Nerves.—If a telegraph wire is cut, electric signals cannot be sent over that wire. If the leg-nerves are cut, pain-signals are not received from the foot. Orders sent from the brain are not received by the foot.

313. *The function of the nerve is to conduct nerve-cell messages.* The common nerves conduct pain- or touch-signals to the cord and brain; the stomach-nerves, pain- or hunger-signals; the eye-nerve, light-signals; the ear-nerve, sound-signals; etc. The *Nerves* also conduct order-signals from the brain, and cord, and ganglia to the muscles. These signals cause the muscles to act.

314. The Ganglia.—The nerve-masses of the chest and ab-do'men, of the heart and lungs, of the stom'ach and glands, send forth orders which regulate the vital functions. They attend to blood-motion, to air-changes, to digestion, and to other internal duties.

315. The Spinal Cord conducts signals to and

from the brain. When the cord is cut across, pain-signals do not affect the brain; neither do motion-signals from the brain reach the muscles.

316. *The spinal cord is a seat of reflex actions.* These actions are seen when a sleeping person withdraws the tickled foot; when dust enters the nostrils and sneezing is caused; when dusts cause coughing, even against the will. After a time, walking and piano-playing become nearly reflex acts.

317. **The Brain** is the master organ. It is the organ essential to and concerned in thinking, reasoning, remembering, knowing, and willing.

318. Summary.—

Nerve-cells—originate nerve-signals.

Nerves—conduct nerve-signals.

Ganglia—control the vital work.

Spinal Cord— { conducts nerve-signals.
 { causes reflex actions.

Brain—is the organ of the mind.

QUESTIONS.

Duties of the Nervous System.

312. What is noticed when a telegraph wire is cut? the leg-nerves? **313.** What is the duty of the nerves? Give examples. In what directions are signals also sent? **314.** What regulate the vital functions? Mention some vital functions. **315.** What is a duty of the cord? What results when it is cut? **316.** What other function has the cord? Give examples. What nearly becomes reflex? **317.** What is the brain? With what is it concerned? **318.** Write a summary of the functions of the nervous system.

CHAPTER XXIII.

HYGIENE OF THE NERVOUS SYSTEM.

CARE OF THE BRAIN.

319. *You must allow the brain an abundance of blood.* All should hold the head erect. All should use loose neck-wear.

320. *You must give the brain good blood.* Blood containing waste or drugs very soon causes improper brain-action. Hence you should breathe deeply of pure air; should eat simple food (290); should keep the skin clean (36); should exercise daily (37); and should abstain from the use of narcotics or stimulants.

321. *You should use the brain daily upon some useful task.* Muscle cannot grow except by food and exercise. The mind cannot grow except the brain have regular graded mental work and proper food.

322. *You must rest the brain.* The young brain needs rests oftener than the older brain. Active interesting exercise rests the brain.

323. *You must give the brain time for sleep.* Sleep is the great resting time of the brain. A child should sleep from ten to twelve hours daily.

324. *Sharp, active, brief study should be the rule.* If you feel stupid and sleepy, open the window and take some active exercise.

325. *If you have constant dull headaches, cease studying (a).* Go out of doors and do some useful work. Engage in sports.

326. *A student should never use tea.* Some students use strong tea in order to keep awake so that they can study many hours. Tea prevents sleep.

The loss of sleep weakens the brain and the body.

327. *A student should never use alcoholics or tobacco.* They weaken the brain-actions. They injure students more severely than they do young working-men.

INJURIOUS ACTIONS INDUCED BY ALCOHOL.

328. *A moderate dose of alcohol* in the blood causes the brain-cells to work improperly. *Alcohol disturbs the mind.*

329. *Several moderate doses* of alcohol, in those not hardened to its use, cause the mind's action to become disorderly. *Alcohol in-tox'i-cates.*

330. *Many moderate doses* of alcohol, as in a "drinking-bout," produce varying effects. Some persons become silly, noisy, or boastful, while others lose control of the temper, become excited and quarrelsome. Some are made acutely insane by alcoholics,

and, under their influence, fight madly and even do murder. *Alcohol often enrages.*

331. *A single large dose may cause death.* Two tablespoonfuls of whiskey have been known to kill a child. *Alcohol may kill.*

332. *The use of alcoholics encourages their use.* Alcoholics are more enticing than rich, sweet foods. The use of beer and wine too often leads to the use of spirits. Children ought not to be allowed to taste or to sip the sugared dregs of alcoholics.

333. *A craving for alcoholics* occurs more frequently in the children of those who habitually use alcoholics than in those of water-drinkers (*b*). The children of in-e'bri-ātes (drunkards) should never use alcoholics. It is perilous for children of "moderate drinkers" to use alcoholics.

ACTIONS OF INJURIOUS AGENTS.

334. **Chloral**, when constantly used, tends to weaken the mind and the will. Its use fixes the "chloral habit." This habit is difficult to cure.

335. **Opium** acts to relieve pain. Yet, in disease where pain is to be a constant symptom for months, years, and perhaps the whole life, it should not be used (*c*).

336. *Opium is a dangerous drug.* A single drop of laudanum (law'da-num) has killed a six months' child. Children are easily excited into con-vul'sions

by opiates (*d*). "Soothing syrups" ought not to be given to children and infants.

337. Tobacco is a poison to young people. It causes the children who use it to become less strong, less alert, less efficient, and less useful.

338. Tobacco hurts the mind as well as the body. (45). In the government schools of France, in the time of Napoleon III., it was found that the smoking students were inferior in all respects to those who did not smoke (*e*).

339. Coffee is a stimulant to the nervous system. It is not a proper drink for children and young people. It is useful for adults who must be exposed, as in out-of-door employments.

340. Tea, as used in our country, is a brain-spur. It is used to prevent sleep, to enable a person to do much work on a poor diet ("bread and tea"), and, worst of all, "to brace up the system" (*f*).

341. Tea is not a proper drink for the young (286). It acts badly on their nerves. If freely used it may cultivate a craving for narcotics.

(a) **Management of "Fits."**—Children subject to fits (epilepsy) should not be pressed in their studies. During a fit or convulsion prevent the person from hurting himself. Place a piece of rubber or cloth between the teeth. Loosen the neck- and chest-garments. Allow plenty of air. When the fit is over encourage sleep by putting him to bed in a quiet, cool room.

(b) **Brain-disease is frequently caused by the steady use of alcoholics.** "Sleeplessness" is one form of alcoholic disease. *In-e-bri'e-ty* is a terrible and lasting form of disease. About one in nine of the insane in our country owe their disease directly to the use of alcoholics! The use of alcoholics is a great cause of crime in our country. It is an active cause of want, misery, ill-health, and disease. *Alcoholics shorten the working period of life.*

(c) **Opium.**—(1) The brain and other nerve-cells will learn to depend upon it. (2) It will need to be taken in larger doses, or more frequently, to produce the desired effect. (3) It will establish the "opium habit." Of the two evils the "opium habit" is held to be worse than constant pain.

(d) *Soothing syrups almost always contain morphia* (mor'fi-ah). The amount which they contain is not stated on the bottle. Most "cough medicines" and some "tonics" contain opiates! The use of "patent medicines" may thus educate a child into a craving for opiates or alcoholics!

(e) *Cigarette-smoking is the most injurious method of taking in the drugs of tobacco* (184). Cigarette-smoke, by its effects on the nerves, often causes young smokers to have an unsteady arm and hand. Its action is such that the young smoker feels weak, spiritless, and heavy, unless he can smoke freely and often. This dependence, this craving, shows that the weakened boy is under the poison-influence of the drugs.

(f) *The habit of tea-drinking* is one that grows on its victim, like the similar ones of opium or alcohol. When a lady feels that she "must have her tea," then it is certain that tea has injured her and is deeply injuring her (e).

The excessive use of tea gives rise to nervous-ness, sleep'less-ness, ir-ri-ta-bil'i-ty as well as in-di-ges'tion (292). Tea works its worst effects on the brain. "To the brain-worker, tea is worse than alcohol." It causes a disease (*Theism*) belonging to the same class as morphin-ism. "Tea-drinking in excess is only less harmful than alcoholic drunkenness."—*Prof. Atfield*.

QUESTIONS.

Care of the Brain.

319. How may you secure to the brain plenty of blood? **320.** What causes improper brain action? What is necessary to make good blood? **321.** Why should you do useful brain-work? **322.** Who most need brain-rest? How secured? **323.** Why should sleep be secured? How much?

324. How should you study? How may you spur the brain to action? **325.** What must be done for constant headaches (héd'-âks)? **326.** Why do students use tea? What results? **327.** From what ought students to abstain? Why?

Actions induced by Alcohol.

328. What is the action of a moderate dose of alcohol? **329.** How do successive doses of alcohol act? **330.** What may be caused by many moderate doses? What may happen? **331.** Mention a fatal dose. Hence? **332.** What is the influence of use? How shown? Hence? **333.** In whom is the alcoholic craving often noticed? Who should not use alcoholics?

Actions of Injurious Agents.

334. What is the action of chloral (klo'ral)? What is difficult to cure? **335.** When should opium be shunned? **336.** Why is opium dangerous? What ought not to be given? **337.** What is the action of tobacco on young people? **338.** How does tobacco influence the mind? How shown? **339.** Who should not use coffee? Why? Who may use it? **340.** For what is tea used? **341.** Why should the young not use tea?

CHAPTER XXIV.

SIGHT AND HEARING.

THE EYE.

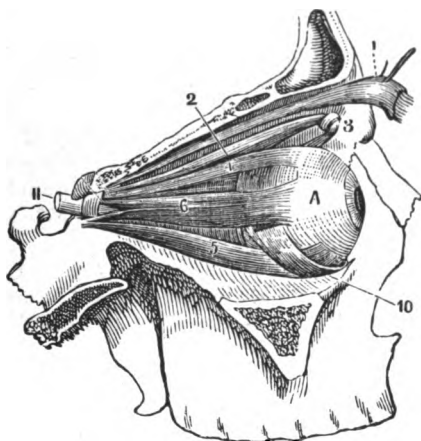


FIG. 42. *The eyeball and its muscles (a part of the orbit is cut away).—A, Eyeball. 1, 2, 4, 5, 10, Muscles. 11, Optic nerve.*

342. The Eyeball is shaped like a globe. (Fig. 42.) It is found in the cavity under the forehead.

343. Structure.—The sides and back of the eye are made of three coats. (Fig. 43.) In (A) front we see the watch-glass-like *cor'ne-a*. (Fig. 43.) The interior contains the *lens* and the *humors* (a).

344. The Retina is the thin, inner coat. (Fig. 43, ^K.) It is a part of the optic nerve.

345. The Optic Nerve extends from the brain to the eye. (Fig. 39,⁸.)

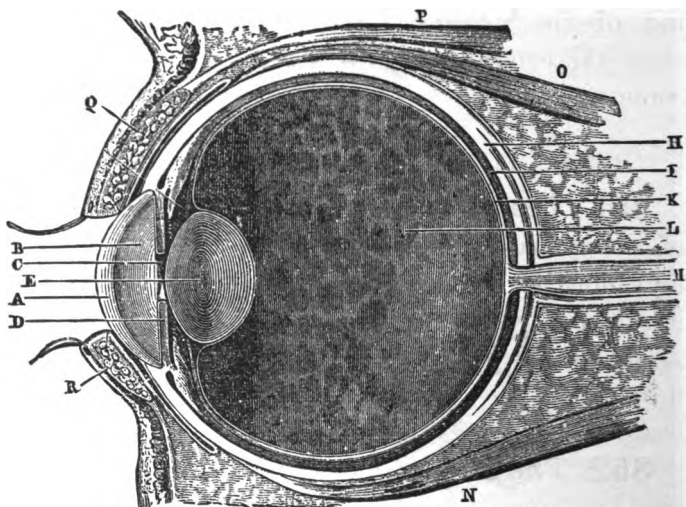


FIG. 43. Section of the human eye in position.—A, Cornea. B, Watery humor. C, Pupil. D, Iris. E, Lens. H, Sclerotic coat. I, Choroid coat. K, Retina. L, Glassy humor. M, Optic nerve. N, O, P, Muscles. Q, R, Eyelids.

346. The Lens is shaped like a “burning-glass.” (Fig. 43, ^E.)

347. Humors.—In front of the lens a few drops

of watery fluid compose the *Watery Humor* (^B). Behind the lens is a jelly-like, clear mass forming the *Glassy Humor* (^L).

348. The Iris is a curtain. (Fig. 43,^D) Its color varies from dark brown in the African to light blue in the Norwegian.

349. The Pupil is the round, black opening in the iris (^O).

350. The Conjunctiva is the thin, outer covering of the eyeball. Dusts cause the con-junc-ti'va to become red.

PROTECTIVE PARTS.

351. Tears.—The surface of the eyeball is kept smooth and moist by the *tears*. They are made by the *tear-gland*. (Fig. 44,¹) In health tears flow off to the nose by the *nasal duct*. (Fig. 44,⁴)

352. The Eyebrows prevent moisture from entering the eyes (*b*). **The Eyelashes and Eyelids** (Fig. 43, ^{Q, R}) act to keep out dusts. **The Pupil** is constantly changing its size. In a dark room it is large; in a bright place it becomes small. These changes are made by minute muscles in the iris.

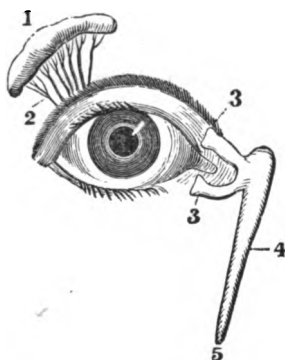


FIG. 44. View of tear-gland and nasal duct.—1, Tear-gland. 2, Ducts leading from the tear-gland to the upper eyelid. 3, Canaliculi. 4, Nasal duct. 5, Nose end of duct.

353. The Eyeball is a kind of camera (c). The *coats* form a globular box. The *middle coat* is black. The *lens* acts somewhat like a glass lens. The *ret'i-na* is the sensitive plate.

HOW WE SEE.

354. Action of Lens.—Rays of light from objects in front of the eye pass through the cor'ne-a, lens, and humors. (Fig. 45.) The lens causes the large picture before us to be reduced to a small picture and to appear distinct on the ret'i-na. The picture makes an impression on the retina. (Fig. 45, ^B.)

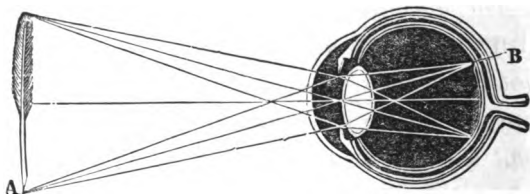


FIG. 45. A, A pen, an inverted image of which is painted on the retina of the eye, at B.

355. Seeing.—The retina sends signals over the optic nerve to the brain. The mind understands the signals and we see.

CARE OF THE EYES.

356. Good Eyes give us no trouble. They enable us to see near and far objects quickly and sharply.

357. Near-Sighted Eyes often cause pain and weariness. They enable a person to see very near objects clearly, while objects at a short distance appear blurred (*d*).

358. *Arrange your bed so that the sun will not shine in your eyes when you awaken.* A sudden bright light injures the retina.

359. *The sunlight is the healthiest light.* Hence do all possible eye-work (studying, fine sewing, etc.) by daylight.

360. *Keep the reading or work at least ten inches from the eyes.* If you cannot see common print well at that distance you should use glasses.

361. *Do not attempt to read or sew by twilight.* The fading light is very trying.

Do not bend over your work. It causes the eyes to become overfull of blood.

Do not study or read while lying down. The strain upon the eyes is vastly increased.

362. *When the eyes become weary and watery, cease using them.* It is better to be less learned than to have very imperfect sight.

THE EAR.

363. The Ear is composed of three portions: the *outer*, the *middle*, and the *inner*. (Fig. 46.) The **Drum-head** is a membrane separating the outer from the middle ear.

364. The Middle Ear contains three minute bones. A tube leads from it to the throat. **The**

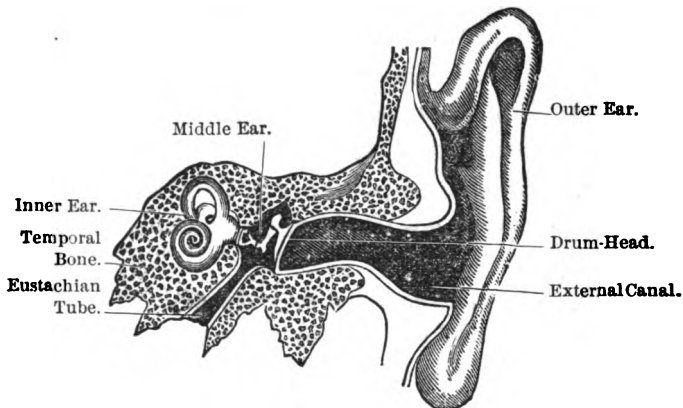


FIG. 46. A section of the temporal bone which holds the organs of hearing.

passages of the inner ear contain the ends of the nerve of hearing.

HOW WE HEAR.

365. The Sound Vibrations (199) enter the outer ear, cause the drum-head to vibrate, move the chain of bones, and affect the ends of the nerve.

366. Hearing.—The nerve of hearing conveys signals to the brain. The mind understands these signals and we hear.

CARE OF THE EAR.

367. Keep the external ear and the canal clean. Never shave out the hairs. Do not use an ear-scoop.

368. *Prevent currents of air from playing on the outer ear.* Do not cut the hair close in cold weather.

INJURIOUS ACTIONS OF ALCOHOL AND TOBACCO.

369. Tobacco often causes deep injury in the young to the retina. *Alcohol and tobacco* may cause weak sight. *Tobacco-smoke* is especially irritating to the eye-surfaces.

370. Tobacco-Smoking often induces throat-disease (244). The throat-disease extends up the tube (Fig. 30, ¹⁰) to the middle ear (Fig. 46, Eustachian Tube). Hence difficulty of hearing and deafness may result.

(a) FOR THE TEACHER. **Directions for Dissection.**—Secure the eye of an ox or sheep. Observe: the transparent, bulging, glass-like *cornea* in front; surrounding and continuous with the cornea, the dirty-white *sclerotica*; and the thin *conjunctiva* adherent to the outer surface of the *sclerotica*. Dissect away the fat from the posterior part of the ball, exposing the junction of the four *recti* (straight) muscles with the *sclerotic* and the round *optic nerve*.

Puncture the cornea, and a small amount of limpid fluid, the *aqueous fluid*, escapes. With fine embroidery scissors cut the cornea from the *sclerotic* close to its union with the latter. The cornea is seen to be transparent, of nearly uniform thickness, and watch-glass-shaped. With the cut surface uppermost, examine the eye. Note: the *iris*, its free edge bounding the dark opening called the *pupil*, and resting on the anterior surface of the capsule of the lens. On the front surface of the lens make a shallow, cross-shaped incision. The tissue which retracts is the *capsule of the lens*. Under slight pressure with the handle of the scalpel the lens will escape from its capsule. Notice the difference in curvature between its front and rear surfaces, the firmness of its tissues, and its transparency. Cause a ray of light to pass through a fresh lens, and note its *refracting* power. Behind the bed in which the lens rested will be seen the glass *vitreous humor*.

Place the eyeball in a shallow dish of water. Allow the vitreous to escape. Looking into the hollow of the ball, note: the entrance at the fundus of the *optic nerve*, and the blood-vessels radiating from that spot. Separate the inner thin membrane, the *retina*, from the next membrane, the *choroid*. Observe that the retina appears like an expansion of the optic nerve, and that most of the black pigment

adheres to the choroid. Outside of the choroid is seen the *sclerotica* of the posterior part of the ball.

Secure several fish-eyes. Freeze them. With a sharp razor make transverse and longitudinal sections. The latter are best made by placing the cornea on cork and cutting from the optic nerve side. When the razor reaches the lens, press it through rather than continue the saw-like motions. Point out the several parts in order.

(b) **Demonstrations.**—Select a boy having a large and prominent eye. Call attention to the *eyebrows*, *eyelids* and *eyelashes*. Point out the method of insertion and the curvature of the upper and lower eyelashes; the fifteen to twenty openings on the free-edge of the lids (ducts of the *palpebral glands*); the lining, pinkish *mucous membrane* of the lids, and the junction of *skin* and *mucous membrane*. When the eye is open, at the inner corner is seen a pinkish, triangular surface (*lacus*) having a small, reddish, conical body (*caruncle*). This is the source of the white secretion which gathers at the corner of the eye. Near the *lacus* in the edge of the upper and lower lid is seen a small opening (*puncta*). These openings admit the tears to the *canalicula*. (Fig. 44, 22.)

Point out the loose, clear, white, thin *conjunctiva* overlying the *sclerotica*; the white or yellowish-white *sclerotica*, the clear, transparent *cornea*, the black *pupil*, and the various-hued *iris*. Place a lamp to the right and a little in front of the face of the student. With a convex lens between the lamp and the eye, direct a pencil of rays on to the cornea. Then call attention to the *cornea*, its form and scleral junction, the *anterior chamber*, containing the *aqueous humor*, the *iris*, and the *lens*. Note the ready contraction and dilatation of the pupil under varying amounts of light.

(c) **Experiment.**—Remove the front convex lens from a pair of opera-glasses, or procure a convex lens with a gradual curve. Hold it opposite a window, and place a piece of white paper behind it to act as a screen. A small reversed picture of the window-frame will appear on the paper. If the paper be moved to a certain distance, varying with each lens, the picture will become clear and distinct, yet with color-rings about the edges. At that distance from the lens the paper is said to be *in focus*. If the paper be moved nearer to, or farther from, the lens, the picture becomes blurred, and the paper is said to be *out of focus*.

Visit a photographer's studio. Request him to point out and name the uses of the essential parts of the camera,—the blackened box, the ground-glass screen, the lens, the diaphragm, and the apparatus for adjusting the lens and the screen to the object. Watch him place the camera and then work the ground-glass screen into the proper focus. When all is ready, put your head under the curtain of the camera and study the reversed image depicted on the glass.

Carefully remove the *sclerotica* and *choroidea* from a small portion of the back of a bullock's eye, near the entrance of the optic nerve. Place the prepared eye in the end of a tube, blackened in the interior, which closely fits the globe of the eye, having the *cornea* forward. You will be enabled to see a distinct reversed image on the retina of the illuminated object in front of the *cornea*.

(d) **The Causes of Near-sight** are many. It may exist at birth. It is often acquired by feeble children by overstraining the eyes, by reading too fine print, or by reading by a dim or poor light. It is unknown among young savages. A few cases occur in the primary school; many cases are found in high schools and colleges.

(e) A Color-blind person usually confuses reds and greens. He fails to match red with shades of red, or green with shades of green. He is thus unfitted for railway or deck service.

QUESTIONS.

The Eye.

342. What is the eyeball? Where found? **343.** How many coats? What is in the interior? **344.** What is the ret'i-na? **345.** Where is the optic nerve found? **346.** Describe the lens. **347.** Speak of the watery humor; of the glassy humor. **348.** How does the iris appear? **349.** What is the pupil? **350.** What is the con-junc-ti'va? When is it injured?

Protective Parts.

351. What is the duty of the tears? How made? How conducted away? **352.** What is the duty of the eyebrows? eyelids? eyelashes? pupil? **353.** How does the eyeball resemble a camera? **354.** Through what do the rays of light pass? What does the lens do? **355.** What is the function of the retina? of the mind?

Care of the Eyes.

356. What can good eyes do? **357.** How do near-sighted eyes act? **358.** How should the bed be placed? Why? **359.** Why study by daylight? **360.** When should you use glasses? **361.** Why not use the eyes at twilight? while leaning over work? while reclining? **362.** When should you cease using the eyes?

The Ear.

363. Of what is the ear composed? What is the drum-head? **364.** What is in the middle ear? the inner ear? What leads to the throat? **365.** How do sound-vibrations reach the endings of the nerve of hearing? **366.** How do we hear? **367.** How should you manage the outer ear? **368.** What should not be done?

Injurious Actions of Alcohol and Tobacco.

369. What is the influence of tobacco? of alcohol and tobacco? of tobacco-smoke? **370.** How may tobacco-smoking induce deafness?

CHAPTER XXV.

THE BODY AND ITS WORK.

THE WORK OF THE BLOOD.

371. The Red Corpuscles are ox'y-gen bearers. The work of the *white cor'pus-cles* is not well known.

372. The Plasma contains the foods for the par'ti-cles of the body. The plasma of the venous blood receives and removes the wastes from the body-particles.

373. The *plas'ma* can visit every particle of the body. The nerve-cell takes from it nerve-food; the muscle-cell, muscle-food; the gland-cell, gland-food.

374. The *plasma* receives new foods from the digestive canal, and from the *lymphatics* (lim-fat'iks). It is constantly giving and receiving.

375. When the *plasma* is laden with drugs (al'-co-hol, chlo'ral, to-bac'co, op'i-um), or with the active parts of stim'u-lants,—tea, coffee, quin'i-a, spices,—or with wastes, then it does not do its work well. Then all parts of the body fail to enjoy peace, comfort, and health.

THE ACTIVITIES OF THE BODY.

376. The Human Body is wonderfully made. It takes in foods (280). It changes the foods to

blood (281). Its parts feed on the blood. The body works; it grows; it suffers wear; it repairs itself; it shows activities.

377. Body Activity is shown in muscle-work (chewing, talking, grasping, moving objects as in working, walking, etc.), in digestion, in blood-motion, in breathing, in growth, in heat-making, in the inner work of the body, and in mind-work.

378. Body-Growth.—At birth the average baby weighs about seven pounds and is about twenty inches tall. The girl continues growing in height until about the twentieth year; the boy, to about the thirtieth (*a*).

379. Alcohol and Tobacco.—It is during the growing period that these agents work the most harm. They act to stunt the growth of bone, muscle, and nerve. They deaden the activity of nerve and gland. They hinder the inner activities of the body. They are of no good use to the young body. *Hence the young, the growing, should not be permitted to use them.*

THE WARMTH OF THE BODY.

380. The Body Heat is largely due to burnings occurring in all parts of the body. The body-burnings take place slowly. They produce *heat, car-bon'ic acid, and ni'tro-gen wastes.*

381. The Heat is set free where the burnings

take place. The burning mostly occurs in the muscles, the brain, the liver, and the digestive canal.

382. Conditions for Burning.—(1) Every part of the body must be supplied with *oxygen*, just as the fire in order to burn well must receive air. Hence breathing and blood-motion must be unhindered.

(2) The *ashes* (ni'tro-gen and min'er-al wastes) and the *smoke* (car-bon'ic acid and vapor of water) must be rapidly removed. (The fire in the stove will not burn well if the grate is clogged and the pipe full of soot.) Hence the kid'neys, the lungs, and the skin must work freely.

383. Heat is mainly { *The Skin* (59).
lost by the way of { *The Air-Passages* (167).

384. Heat Regulation.—The blood-flow is regulated by nerve-cells. This nerve-control is delicate. In health heat-losing balances heat-making.

385. Alcoholics, when taken by the young, or the temperate, overcome the nerve-cell control. The blood rushes to the flushing skin. Hence the heat-loss, in cold weather, exceeds the healthy loss and the body gets chilled. *Alcoholics, hot or cold, should not be taken before going out into the cold* (b).

ALCOHOL AND EXPOSURE.

386. Alcohol and Cold.—Most Arctic explorers affirm that the use of alcohol unfits a man to resist intense cold (c).

387. Alcohol and Heat.—The use of alcoholics in the tropics favors “heat-stroke” and bowel-disease (*d*). Alcoholics are more injurious in hot than in temperate climates.

388. Alcohol and Disease.—In times of cholera, yellow-fever, and plague the intemperate are earlier attacked than the temperate. The death-rate among them is also higher.

389. Tobacco and Cold.—It was found in the Greely Expedition (1882–84) that those who did not use tobacco (eight) except one lived to come back. All the users (eleven) perished in the North!

THE WASTES OF THE BODY.

390. Heat and Wastes.—When we work, talk, or walk heat is set free and wastes are made. When we eat, digest, and secrete heat appears and wastes are formed. When we read, study, plan, and think heat and wastes result.

391. The Body Wastes are of no use in the body. They collect in the blood. If they are kept long in the blood they induce heaviness, headache, and even disease.

392. Waste Matter is cast out { *By the Skin* (81),
By the Lungs (169),
By the Kidneys (394),
By the Bowels (278).

THE KIDNEYS.

393. The Kidneys are two in number. They are found in the right and left side of the abdomen.

(Fig. 11.) They are glands.

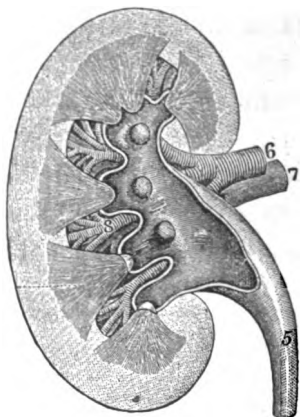


FIG. 47. A section of the kidney.—6, 7, Artery and vein of kidney. 5, Ureter leading to the bladder.

394. Function.—Their work is to filter out the extra *water* of the blood, to cast out the *ni'tro-gen* and *min'er-al wastes* and to remove *poisons* from the blood. Their product is the urine.

395. Alcoholic Kidneys.—A small amount of alcohol disappears in the adult body. That part which is not used up in the body is mostly cast out by the kidneys (181). The use of alcoholics in excess is a great cause of "kidney-disease."

396. Spleen.—The work of the spleen, as well of some other organs, has not yet been determined.

SUMMARY.

397. The Human Body is fearfully and wonderfully made. The CREATOR has endowed it with life and mental power that it may perform useful work. *We should so use our body that the world will be the better for our having lived in it.*

398. We all desire to avoid pain and disease. We all want to "get on in the world." We all know that ill-health is a hindrance to mind- or body-work. Ill-health and disease is, however, to a large extent preventable. *It is our duty to try to keep well.*

399. Ill-Health is encouraged, the number of sick days in the year is increased, the working period of life is shortened, the efficiency and usefulness of the body and mind is lessened, and misery and pain is assured by more or less constantly

*Breathing an impure air,
Drinking a tainted water,
Eating unwholesome food,
Living in damp, sunless rooms,
Neglecting out-door exercise,
Wearing unsuitable, close-fitting clothing,
Omitting to keep the skin clean,
Failing to employ the mind usefully,
Postponing the correction of defects in sight,
Pursuing injurious occupations,
Using alcoholics.*

400. Growth, endurance, usefulness, and efficiency are markedly lessened in the growing boy and girl, in the young man and young lady, by

*The use of confectionery,
The use of appetizers,
The use of tea or coffee,*

The use of opiates, chloral, etc.,

The use of tobacco,

The use of alcoholics.

(a) **FOR THE TEACHER.** Boys and girls attain half ($\frac{1}{2}$) of their average weight and about eleven-thirteenths ($\frac{11}{13}$) of their stature before the thirteenth year. Hence the food given in this rapid-growing period should certainly be rich in bone, in muscle, in gland-making materials.

(b) **Heat-Control.**—If the control is disturbed then too much blood may go to the skin, causing too rapid heat-loss, or too much to the internal organs, causing too much heat-making. In health, the balance is so well kept that the body temperature remains at about 99° F. day and night, summer and winter, in Cuba and in Labrador. The control is so prompt that a healthy person can go from a hot to a cold place with little concern.

Illustration.—Sir John Richardson was an abstainer. He spent a winter in British America, as near the Arctic Sea as the party could reach. Without putting on his great-coat, he frequently went from the log hut (temp. 50° F.) to the observatory out of doors (temp. 50° F. below 0°) and remained out ten minutes. He suffered no ill effects from the great change of a *hundred degrees* (c)!

(c) **Management of Frost-Bite.**—*To restore circulation and sensibility, rub the frozen part with snow, or apply iced water. Keep the sufferer at first in a cold room, and let the return to a higher temperature be gradual and cautious, else gangrene may supervene.*

(d) **Management of "Heat-Stroke."**—*The majority of "sun-strokes" are merely the effects of the heat, not of the direct rays of the sun. Hence they should be called "heat-strokes." Apply cold water and ice to the head. Pour salt water on the head. If the person can swallow give him ice freely. Put the patient in a cold bath. GIVE NO ALCOHOLICS. The object in view is to reduce the temperature of the blood.*

Prevention of Heat-Stroke.—*Wear loose-fitting garments. In very hot, sultry weather be moderate in your movements. Avoid hurry and worry. Drink freely of warm tea or coffee and cold water. AVOID "MADE DRINKS" AND ALCOHOLICS. To prevent the direct action of the sun's rays, wear a ventilated hat; place a green leaf in the hat; protect the back of the head; use a sun-umbrella.*

QUESTIONS.

The Work of the Blood.

371. What is the work of the red corpuscles? of the white?
 372. What is found in the plasma? 373. What may be taken from the plasma? 374. What is received by the plasma? 375. What injures the plasma? What may wastes or drugs induce?

The Activities of the Body.

376. What can the body do? What is its work? 377. Mention the body activities. 378. What is the weight and stature of a

babe? When does growth cease? 379. When do alcohol and tobacco work most injuriously? What do they do? Hence?

The Warmth of the Body.

380. To what is body-heat due? What is formed? 381. Where is the heat mostly set free? 382. Why must oxygen be freely provided? What must be removed? Why? Hence? 383. How is the heat lost? 384. How is the blood-flow regulated? What is balanced? 385. What is the action of alcohol? What follows in cold weather? Mention a true maxim.

Alcohol and Exposure.

386. What is the influence of al'co-hol-ics in cold countries? 387. What do alcoholics favor? Where very injurious? 388. What diseases are favored by alcoholics? 389. What was noticed in the Greely Expedition?

The Wastes of the Body.

390. What causes the making of heat and of wastes? 391. What becomes of the wastes? What trouble may they cause? 392. How are the wastes cast out?

The Kidneys.

393. How many kidneys? Where found? 394. What is the duty of these glands? 395. What becomes of a portion of an absorbed alcoholic? of another portion? What may result? 396. What is the duty of the spleen?

Summary.

397. Why has the human body been richly endowed? Hence? 398. What do all desire? What should we know? What is a duty? 399. Mention, in turn, actions which are unfavorable for body-work and efficiency. 400. Mention, in turn, actions which markedly injure the health of the growing person.

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